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Subject:	USGS Report for the West Vermont Site
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USGS finalized their report for the West Vermont site (see attached). If you have any questions, you can address them to me.

Thank you,
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Evaluation of Localized Groundwater flow in a Contaminated Surficial Aquifer in Speedway, Indiana, 2014

By Amy M. Gahala

Prepared through Interagency Agreement with the U.S. Environmental Protection Agency

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Evaluation of Localized Groundwater flow in a Contaminated Surficial Aquifer in Speedway, Indiana, 2014

By Amy M. Gahala

Abstract

The localized groundwater flow has been evaluated to determine the potential for contaminants to migrate from a source site towards a southwest residential area. Existing water level data and water quality parameter data were reviewed and used to create water-level contour maps and iso-concentration maps. Vertical gradients were calculated for nested well sites and contoured to show locations of upwards and downwards flow. Iso-concentration maps were created for specific conductance, PCE, VC, and methane to delineate plume location and potential plume migration. This information is provided to EPA officials for assessing the source of the residential area impacts.

Water-level contour maps were created for two observed extreme (wet and dry) groundwater elevation periods and one recent period. The Dry period induced radial flow from Source Area B. The Wet period shifted this radial flow westward. The recent groundwater elevation data suggests radial flow at the Source Area B and radial flow west of the contaminant source. The deep aquifer has a westward flow component in the northeastern half of the site and south-southeastern flow towards the southern half of the site.

Vertical gradients indicate a combination of upwards and downward vertical flow within the aquifer. On average there is a slight upwards groundwater flow at the source areas and a strong downwards vertical gradient near the residential area. This upwards vertical gradient at the source area is consistent during dry period, but during the wet period, the vertical gradient reversed slightly downward and the southern half of the site became an upward gradient.

Plume locations were identified with specific conductance data and consistent with previous plume delineation reports (Beodray, 2013). Comparison of specific conductance for seven separate time periods indicate a possible westward flow component within the aquifer but an overall southeast flow direction. Specific conductance was also comparable to the PCE, VC and methane iso-concentration maps and they also indicate a possible westward flow component.

The groundwater elevation data, specific conductance and water quality data allude to the presence of a preferential flow path from the source areas to the residential area. Heterogeneous geologic conditions within the aquifer produce localized radial flow and upwards vertical flow from the Source Area B and the groundwater then flows through the higher conductive sands and gravels. The flow resumes its southeastern flow direction south of the source areas.

Acknowledgements

This report is based on data collected by the environmental consulting agencies on behalf of the US EPA. The author thanks Dan Strobridge and Frank Beodray of Weston Solutions, Inc., for their help and collaboration.

Introduction

An analysis of existing data has been completed to help determine potential contaminant transport pathways at West Vermont Street, Speedway, Indiana. The West Vermont Drinking Water Contamination Site is located within a residential area in Speedway, Indiana in which 25 homes rely on private drinking water wells as their only source of water (Figure 1). Three homes in this residential area have had vinyl chloride and or perchloroehtylene (PCE) detected in their wells. Releases of PCE and its degradation products originate from nearby source areas located beneath Michigan Meadows Apartments and Michigan Plaza (figure 2). There is an additional source of trichloroethylene (TCE) and related degradation products originating from Genuine Parts. PCE was detected very sporadically at low levels, 10-15 years ago at the Genuine Parts site. PCE may or may not be migrating from the Genuine Parts site. The direction of groundwater flow in the area is not completely understood and the PRP (Potentially Responsible Parties) for the Michigan Plaza Site has asserted that groundwater from their site does not flow toward the residential area; therefore, they are not responsible for the contamination of drinking water wells. The regional groundwater flow direction is believed to be generally south and southwest, based on a series of potentiometric surface maps (Grove 1,2). The local groundwater flow direction has been determined in this analysis using groundwater elevation and water quality data.

Figure 1. Regional view of the West Vermont Street Contamination Drinking Water Area Site and residential area

A review of available groundwater elevations (GWE) and water quality samples that have been collected from 2005 to present by environmental consulting firms representing the PRP and the USEPA (2005-present by Mundell and Associates, Inc.; and 2010-present by Weston Solutions, Inc.) has identified a period of high groundwater elevations (wet) and a period of low groundwater elevations (dry). The "wet" and "dry" GWE data have been used to create water-level contour maps on a local scale to assess transient changes in groundwater flow direction. A water-level contour map was also created for a more recent set of GWE data to represent "normal" conditions (3-1-2013). The "normal" is representative of typical or average conditions because the GWE fell between the two extremes (wet and dry). Vertical gradients have been calculated and presented in a contour map depicting areas of upward and downward vertical migration for dry, wet, and averaged data. Elevated specific conductivity (SpC) concentrations were observed at locations with contamination, therefore, iso-concentration contour maps have been created for SpC to identify areas of higher conductivity to represent potentially contaminated areas. Changes or shifts of the SpC plume were used to show localized groundwater flow direction (Degnan and Brayton, 2008). The SpC maps are also compared to PCE, VC and methane iso-concentration maps to verify locations of plume delineation and migration pathways.

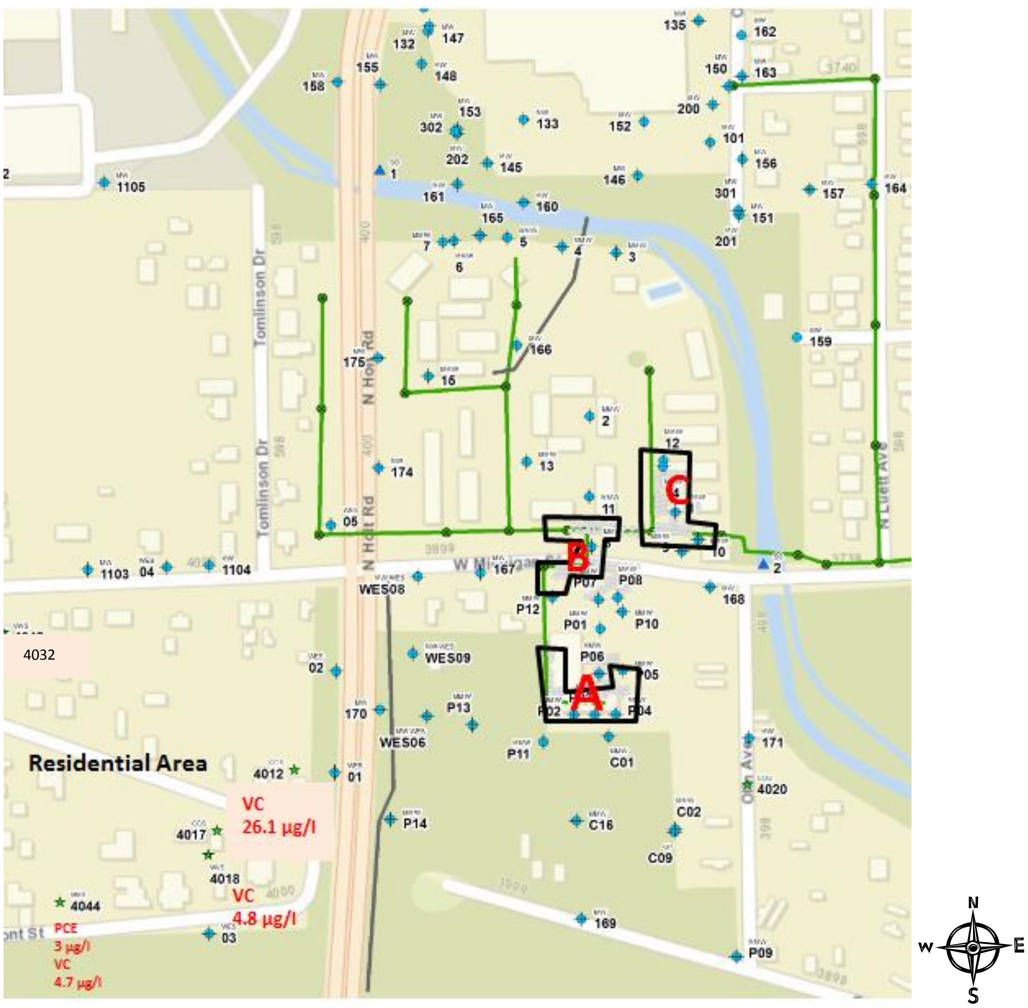


Figure 2. Locations of Source Areas within the site and the residential area.

Purpose and Scope

The purpose of this report is to present potential local groundwater flow directions based on available data at the West Vermont Drinking Water Contamination Site in Speedway, Indiana. The data was not collected with the intention of determining groundwater flow paths, but rather to define the existing contaminant plume and assess remediation efforts. Data gaps exists where sampling was omitted or where monitoring wells were only recently installed. Therefore, this limits the ability to make any interpretations without further investigation. The scope of work uses a compilation of existing water level data, SpC and contaminant concentration data to define the plume and observe the transient changes in the groundwater elevation and plume delineation. The water level data was used to create water-level contour maps for dry, wet and normal periods observed in the records. The water levels were also used to evaluate the vertical hydraulic gradients within nested wells for dry and wet periods and the cumulative data was averaged and contoured to depict typical vertical gradients. The specific conductance data taken during sampling was used to determine contaminated areas and potential flow paths. The specific conductance data is compared to PCE, VC and methane iso-concentration maps to further delineate the plume and migration pathways. This report presents information needed by EPA officials to determine the best course of action for preventing further residential area contamination.

Description of Study Area

The West Vermont Drinking Water Contamination Site is located in the city of Speedway, Indiana and is bounded to the north by West 10th Street, Grand Avenue to the west, the City of Speedway WWTP to the south, and Little Eagle Creek to the east. The site covers an area of approximately 0.118 square miles (0.306 km^2). Land-surface altitude ranges from about 698 to 720 feet (ft). Land cover in the area consists of mixed residential and commercial.

Approach and Method

Existing water elevation data from previously installed wells are used to develop water-level contour maps and vertical hydraulic gradient maps from 2005 to present. Water level measurements were made with electric tape by Mundell and Associates, Inc., and Weston Solutions, Inc., on behalf of the PRPs and the US EPA. Monitoring wells have been previously surveyed by a licensed surveyor subcontracted by Mundell and Associates, Inc. and by Weston Solutions, Inc. Groundwater flow directions need to be understood at local, intermediate and regional scales in order to assess the potential for contaminant transport. The local scale groundwater flow directions within the alluvial aquifer were assessed by dividing the monitoring wells into shallow, intermediate and deep aquifer zones. The shallow zone is defined as wells screened at or above 686 ft amsl. These wells are typically water table wells. The intermediate zone is in the middle of the aquifer at 670-685 ft amsl and the deep zone wells are screened at 670 ft amsl or less. The deep monitoring wells are closest to the clay layer where present. Also, because this is all the same aquifer, all the water level data was combined for the shallow, intermediate, and deep zones to determine the intermediate scale groundwater flow directions. Potentiometric surface maps were created for synoptic data available on 7-30-2012 and 3-1-2013. These dates provided a larger data set which included the newer wells installed near the residential area. A regional scale groundwater elevation contour map was also created to determine the general flow direction for the entire region depicted in Figure 1 (GWE data from 12-1-2011). Well details and data can be found in the Appendix of this report.

A review of water level data collected indicated a period of low GWE (10/11/2010) and a period with high GWE (4/28/2011). Potentiometric surface maps were created for the two extremes, denoted as "Wet" and "Dry," for all three aquifer zones to evaluate the transient groundwater flow directions. A potentiometric surface map created from the most recent synoptically available GWE (3/1/2013), denoted as "Normal" is compared to the extremes. The term "normal" is being used to describe groundwater elevation data that falls between the range of the two extremes (dry vs. wet).

Vertical hydraulic gradients for clustered well sites were calculated to determine the vertical direction (upward or downward) of groundwater flow within the aquifer. Groundwater elevation data from the shallow monitoring wells were subtracted from the deep monitoring wells (shallow minus deep) and the difference is divided by the distance between the two open boreholes for the wells (in feet). Shallow monitoring well GWE that is lower than the deep has a difference that is negative (upward flow). Deep monitoring well GWE that is lower than the shallow GWE has a difference that is positive (downward flow). The negative and positive differences are contoured to display locations of upward and downward flow for the wet and dry GWE data sets. The vertical gradients were also observed through time and the average is mapped to determine the consistency of the vertical movement of the groundwater. Values greater than 0.05 and -0.05 were considered significant for vertical flow direction evaluation.

The field sampling parameter, specific conductance, is also used to delineate plume extent and potential flow paths. Specific conductance is a measure of dissolved ions within the water and is routinely measured during field sampling and used as a general water quality indicator (ITRC, 2008). Specific conductivity has been widely used as a tracer for surface water and groundwater flow paths (Cox and others, 2007; Winter and others, 1998; Marin and others, 1998; Smith and others, 1991). Instruments used for field parameters measured were calibrated daily before use. Iso-concentration maps were created for specific conductance from 2007 through 2013 with all aquifer zones (S, I and D) combined. For some years, the aquifer was divided into zones to further clarify plume source and flowpaths.

This site has received periodic edible oil treatment in 2007, 2009, and 2013. The edible oil boosts the microbial degradation process and accelerates reductive dechlorination (Henry, 2010). Chloride is a general water quality parameters that is produced by anaerobic dechlorination of chlorinated solvents released in the groundwater. Elevated levels of chloride indicate that dechlorination is occurring. According to the ITRC (2008), chloride levels that are found to be three times background can be used to identify plume locations. Chloride has not been measured at this site, however, specific conductance has been shown to have a strong correlation to chloride ions in groundwater (USGS, 1995; Christensen, V.G and others, 1999; Kunze and Stroka, 2004). The data provided has indicated an imperfect (r^2= 0.10) correlation between contaminants and SpC. However, there was a general observation of higher SpC at wells near the source area. The poor correlation may be due to interference from the edible oil treatments and general data variability. Specific conductance is being used as a general proxy for chloride in this analysis. If specific conductance is 2 to 3 times background (in lieu of using chlorides), it is used to indicate possible contaminant location and plume migration. The lowest detected specific conductance data have been around 500-700 uS/cm. Therefore, an SpC greater than ~1200 µS/cm was assumed to be influenced by contamination.

The specific conductance iso-concentration maps are compared to PCE, VC and methane iso-concentration maps to verify that it is appropriate to use elevated specific conductance as a potential indicator for plume delineation and to help assess potential groundwater flow paths.

Hydrogeologic Setting

The West Vermont Contamination site is situated on unconsolidated glacial deposits and glacial outwash material consisting of sands, silts and clays. According to the IDNR, Division of Water (2011), the principal freshwater-bearing aquifers underlying the site include the surficial New Castle/Tipton Complex Aquifer System and the White River and Tributaries Outwash Aquifer System. The New Castle/Tipton Complex Aquifer System consists of thick sequences of clays with interbedded sands and gravels that are highly variable in thickness, depth and lateral extent. This aquifer is mapped northeast of the site. This aquifer is considered prolific and adequate for domestic and high-capacity users. The White River and Tributaries Outwash Aquifer System is the primary shallow aquifer for the site and it consists of glacial outwash overlain by an intermittent and irregularly thick layer of clay and silt deposits.

A review of the borehole well logs for this site confirms the presence of intermittent and irregularly thick layer of clays and silt deposits. The clay layer thins dramatically towards the east and northeast and is altogether missing towards the north. It is thickest (25-30 ft) towards the south and southwest. The clay is described as non-plastic, stiff, and moist to dry.

Direction of Groundwater Flow

Groundwater flow directions were determined at the three scales for groundwater flow: local, intermediate, and regional. Contaminant transport is primarily controlled by local and intermediate flow directions (Focazio and others, 2002).

Approximately 70 monitoring wells were used to determine the local groundwater flow direction in the shallow, intermediate and deep aquifer zones (figure 3). The zones are divided in the shallow zone (>686 ft amsl) which is at or near the water table; the intermediate zone (670-685 ft amsl) (middle of aquifer); and the deep zone (<670 ft amsl), which is closest to the clay layer (if present). All the wells are within the same aquifer. Potentiometric surface maps were developed for the shallow, intermediate, and deep portions of the aquifer for the wet, dry and normal periods in order to determine the localized transient flow patterns. The intermediate groundwater flow directions were obtained by creating a potentiometric surface map for all the aquifer wells within the area as shown on figure 2. The regional groundwater flow directions were obtained by creating a potentiometric surface map for all the aquifer wells within the area shown on figure 1 (approximately 180 monitoring wells).

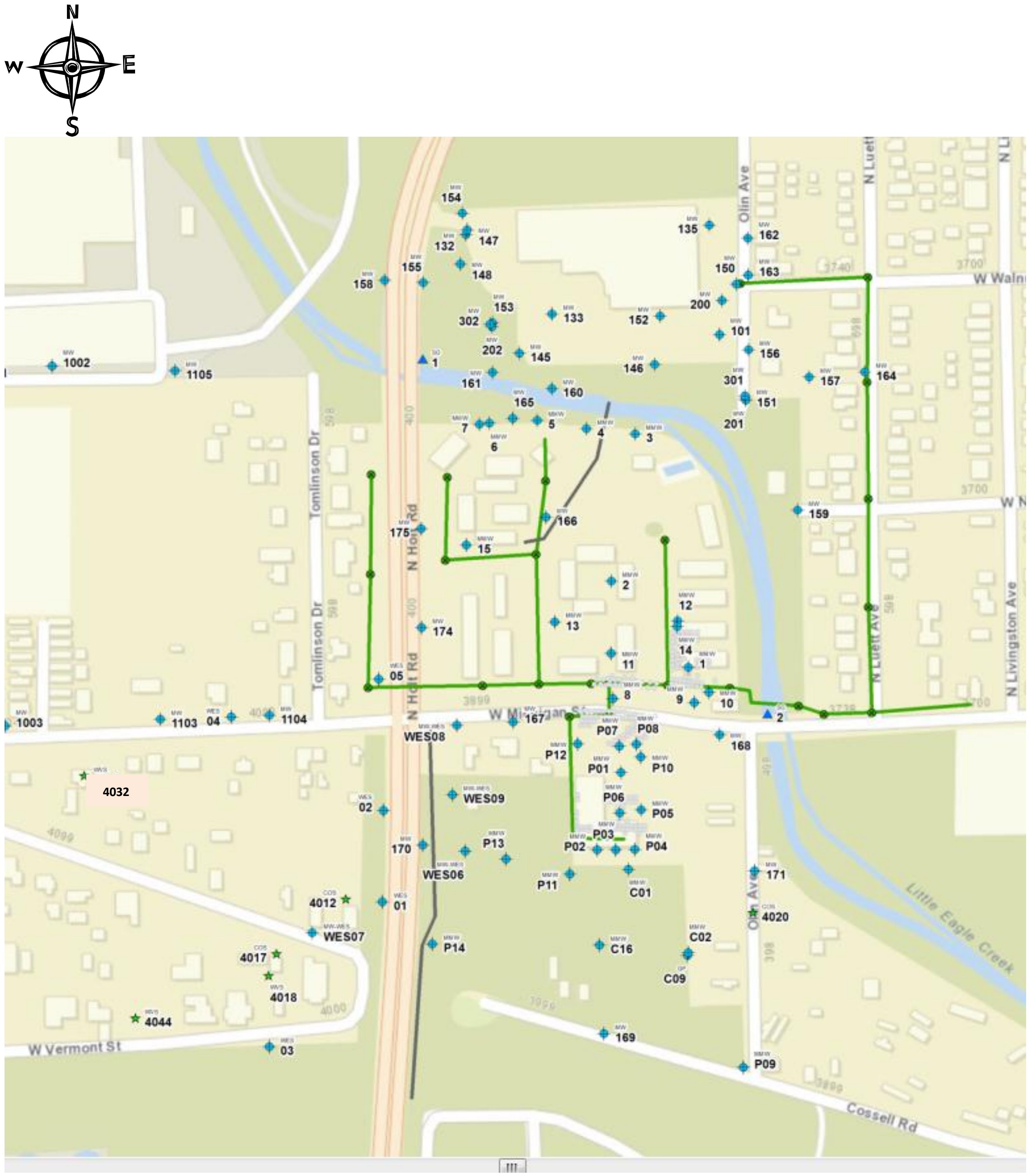


Figure 3. Monitoring Well Locations

Local Scale

Groundwater in the shallow aquifer zone generally flows from areas of high hydraulic head (interstream divides) to areas of low hydraulic head at surface-water discharge areas (i.e. Little Eagle Creek and Eagle Creek). The direction of flow is perpendicular to the water-table contours. The highest hydraulic head occurs north and northwest of Michigan Street at the Michigan Meadows Apartments . The lowest hydraulic head occurs at MMW-8S and at discharge zones east and south towards Little Eagle Creek (Figure 4). Periods of low groundwater elevations within the shallow aquifer show a predominately southern flow with some localized areas of higher hydraulic head at MMW-11S, MMW-P-11S and MMW-8S (figure 5). Periods of high groundwater elevation (wet) within the shallow aquifer increase the occurrence of some radial flow at MW-167S, MMW-P-10S, MMW-P-01 and MMW-C-01 (figure 6).

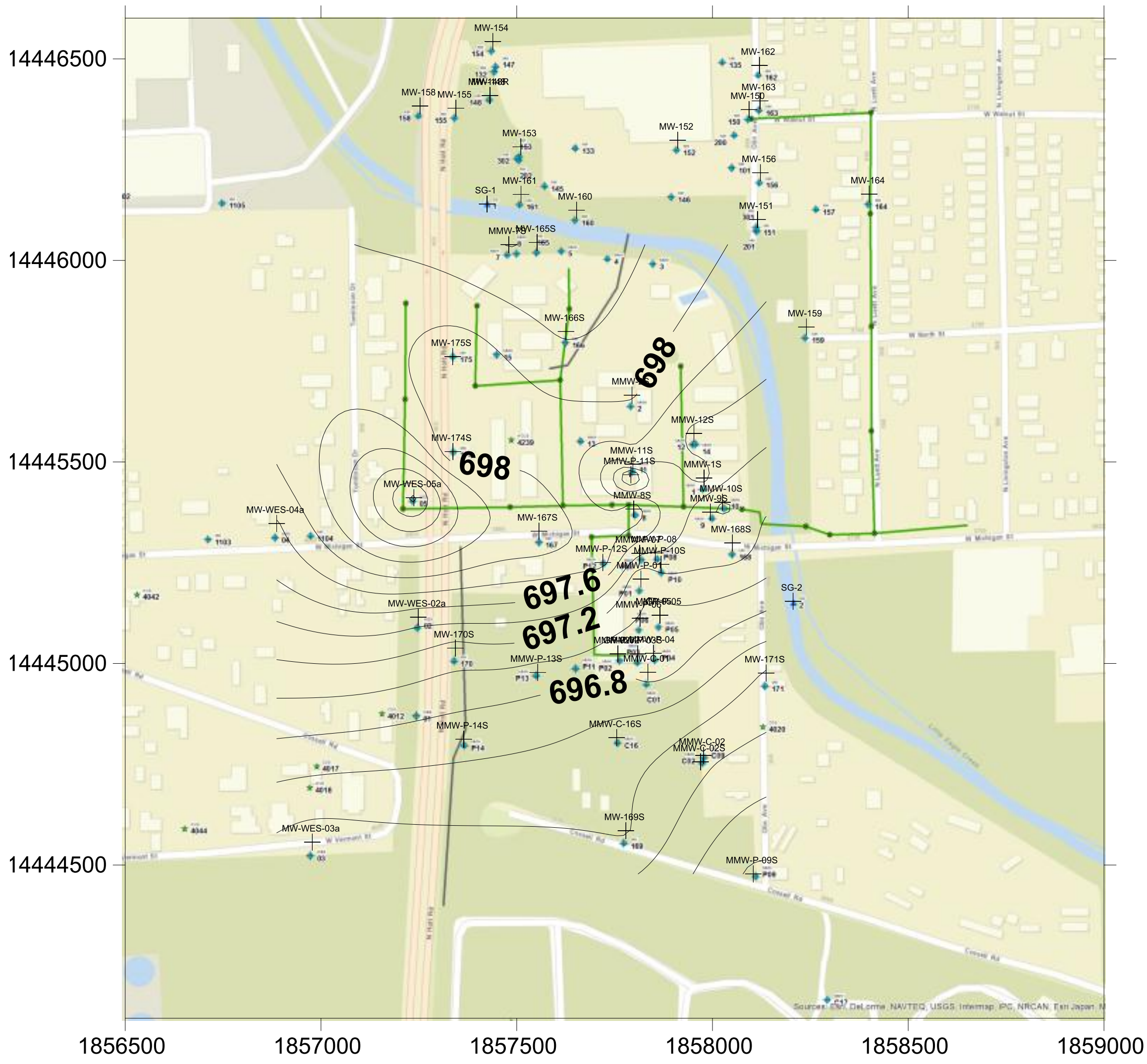


Figure 4. Shallow aquifer zone water-table contours for the normal GWE data.

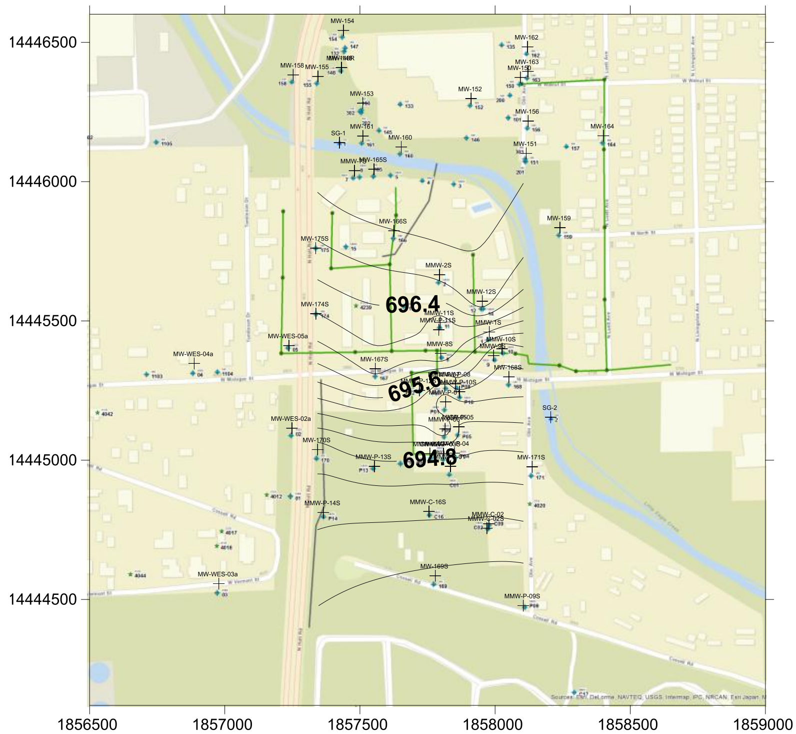


Figure 5. Shallow aquifer water contours for the dry period GWE data.

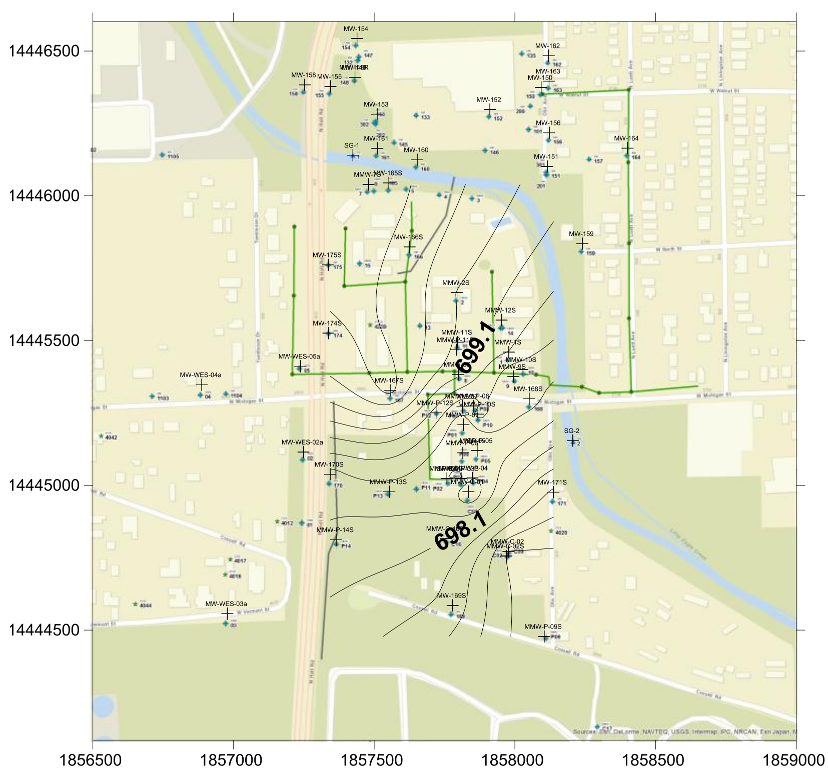


Figure 6. Shallow aquifer water table contours for wet GWE data.

The intermediate portion of the aquifer has a primarily south-southeast flow (figure 7). The period of low groundwater elevation (dry) indicate pronounced radial flow from monitoring wells within the Michigan Meadows Apartments location (figure 8). The flow direction shifts exclusively southeast during the wet period (figure 9).

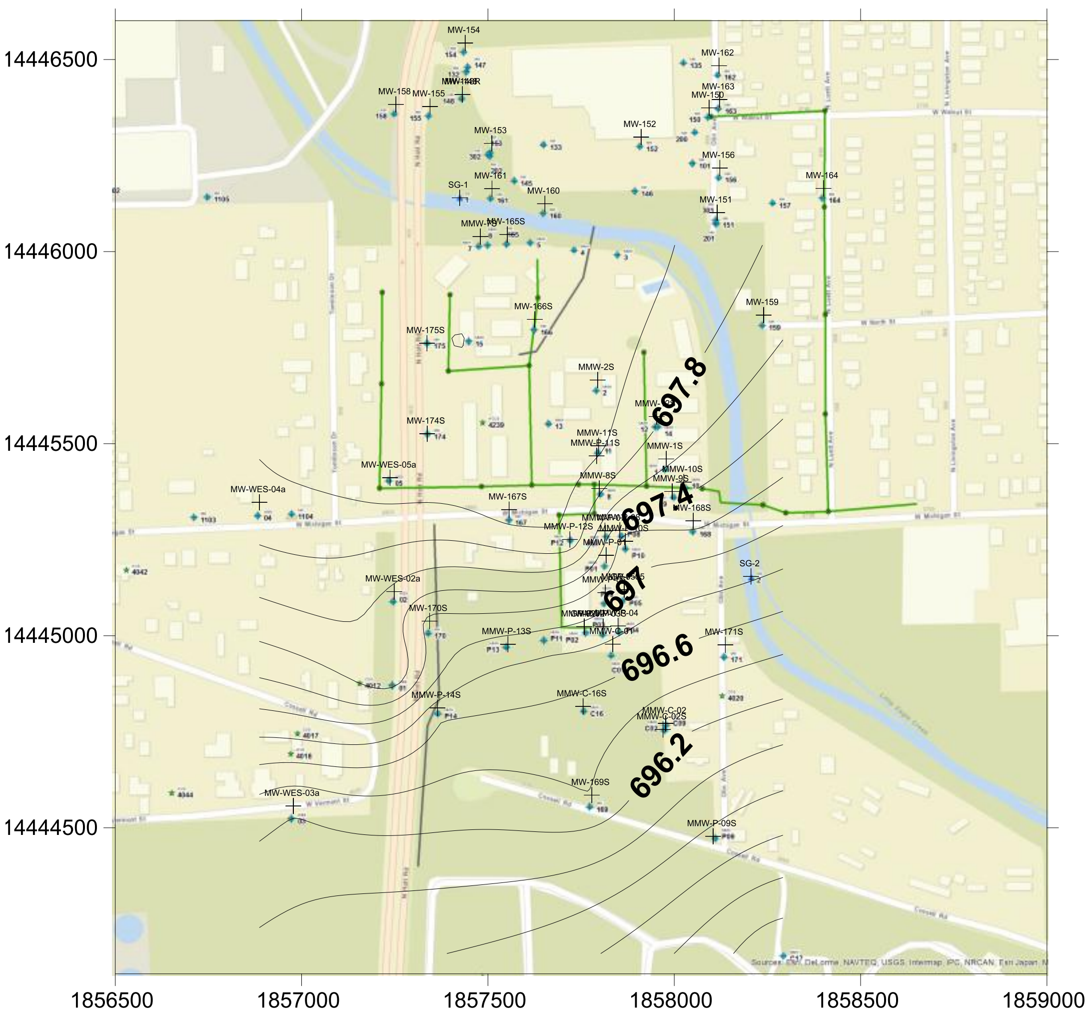


Figure 7. Intermediate zone water table contour map for recent GWE data.

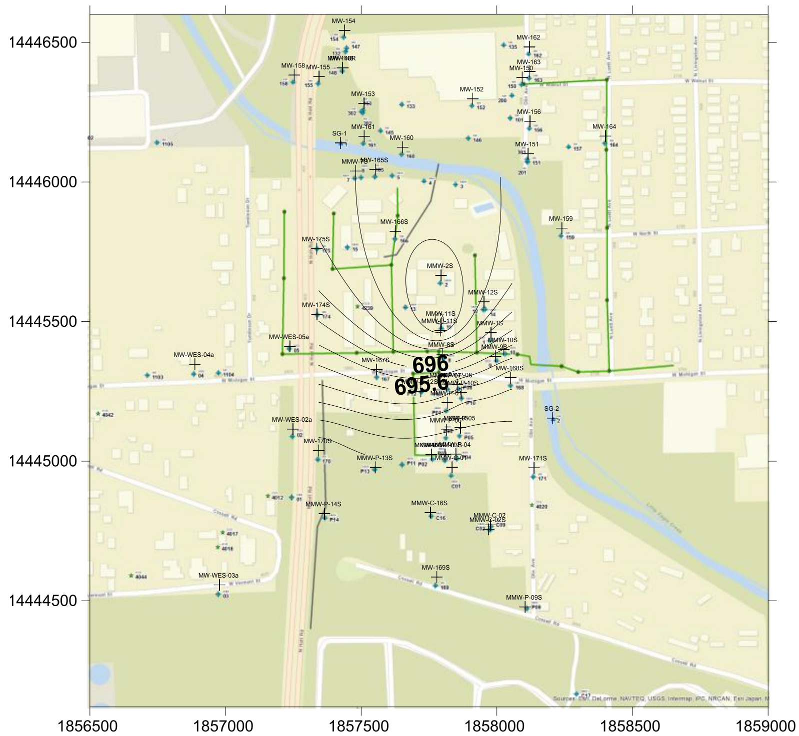


Figure 8. Intermediate aquifer water table contours for dry GWE.

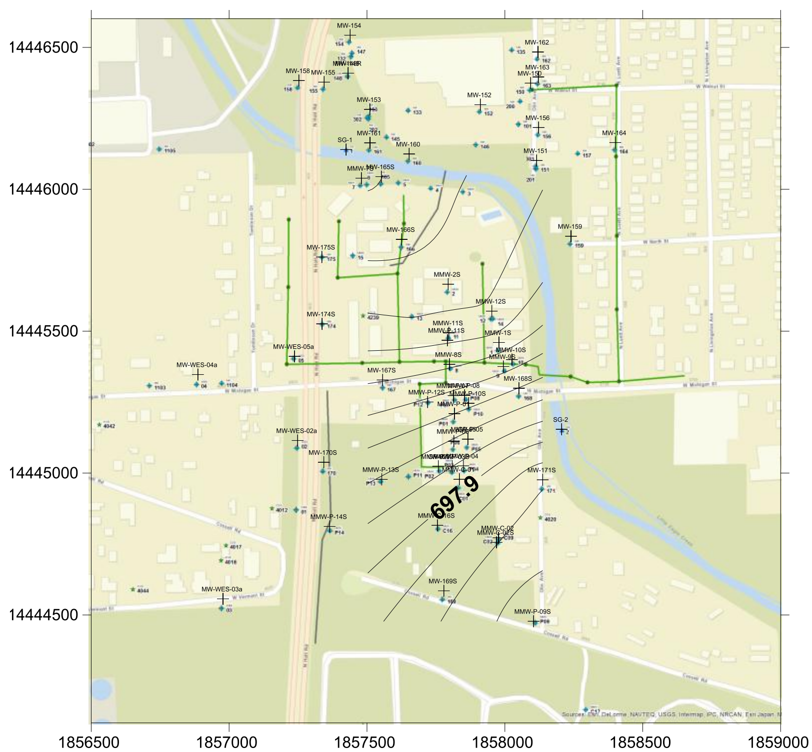


Figure 9. Intermediate aquifer water table contours for wet GWE.

The deeper portion of the aquifer exhibits radial flow at the Michigan Meadows Apartment property with a westward flow component towards the residential area, however, the flow resumes a south-southeastern direction after Michigan Plaza (figure 10). Only a few data points were available for the dry and wet periods in the deep wells. These points are predominately located at Source Area A and southeast. The data indicates a southeastern flow direction. The wet period data was also limited to the Michigan Plaza area and it depicted a southeasterly flow direction (figure 11 and 12).

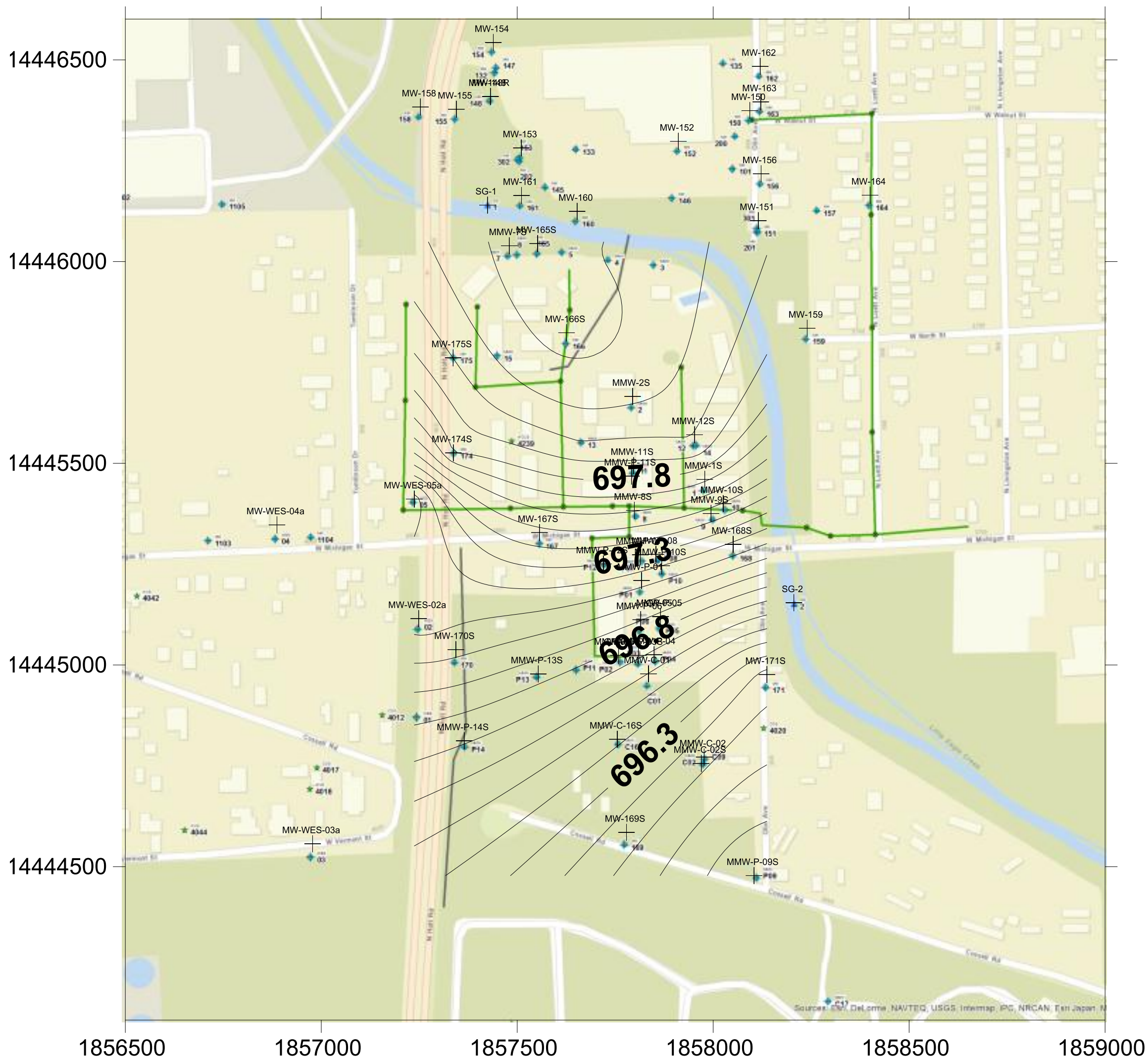
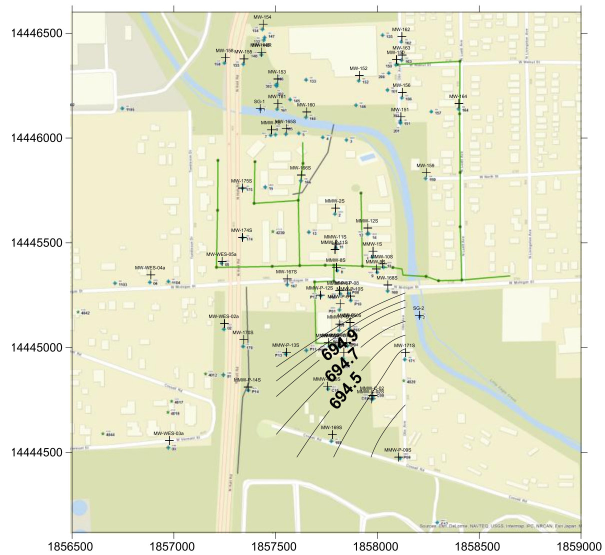
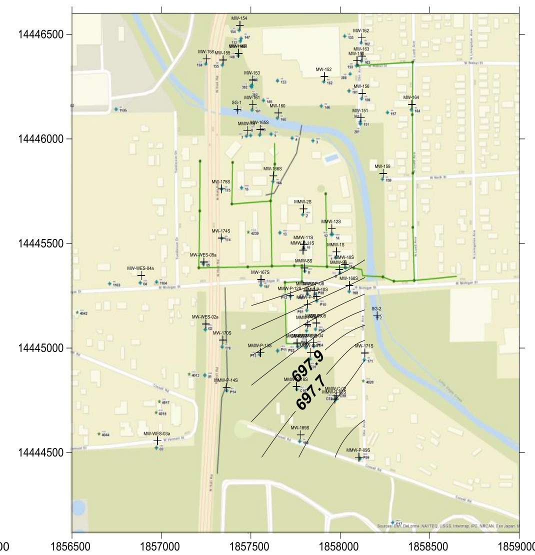


Figure 10. Deep aquifer water-table contours for recent GWE data.





Figures 11 and 12. Deep aquifer “dry” water table contours (left) and “wet” water table contours (right).

The contoured dry, wet and normal data GWE data reveals the transient nature of flow paths for the aquifer. Potentiometric surface at the Michigan Meadows Apartments expresses some radial flow that also moves westward during high GWE periods. This transition of groundwater flow could potentially divert some contaminants from the Source Areas westwards.

Intermediate Scale

The Intermediate Scale potentiometric surface maps were created for all the wells within the aquifer. The Intermediate Scale Flow directions are assessed by combining the shallow, intermediate, and deep monitoring well data and contouring the groundwater elevations. Synoptic GWE data from 7-30-2012 (figure 13) shows sinuous and radial flow north of Michigan Street with a westward flow component along Holt Rd. Flow direction is typically southeast and south with a few areas of radial flow and some westerly flow. There is a groundwater divide running east-west from MMW-1S to WES-02.   Synoptic GWE data for 3-01-2013 (figure 14) also shows similar radial flow pattern along the 697.0 contour slightly north and along Michigan St with a slight westerly flow component along Holt Rd at the 697.5 contour near WES-09 and WES-08.

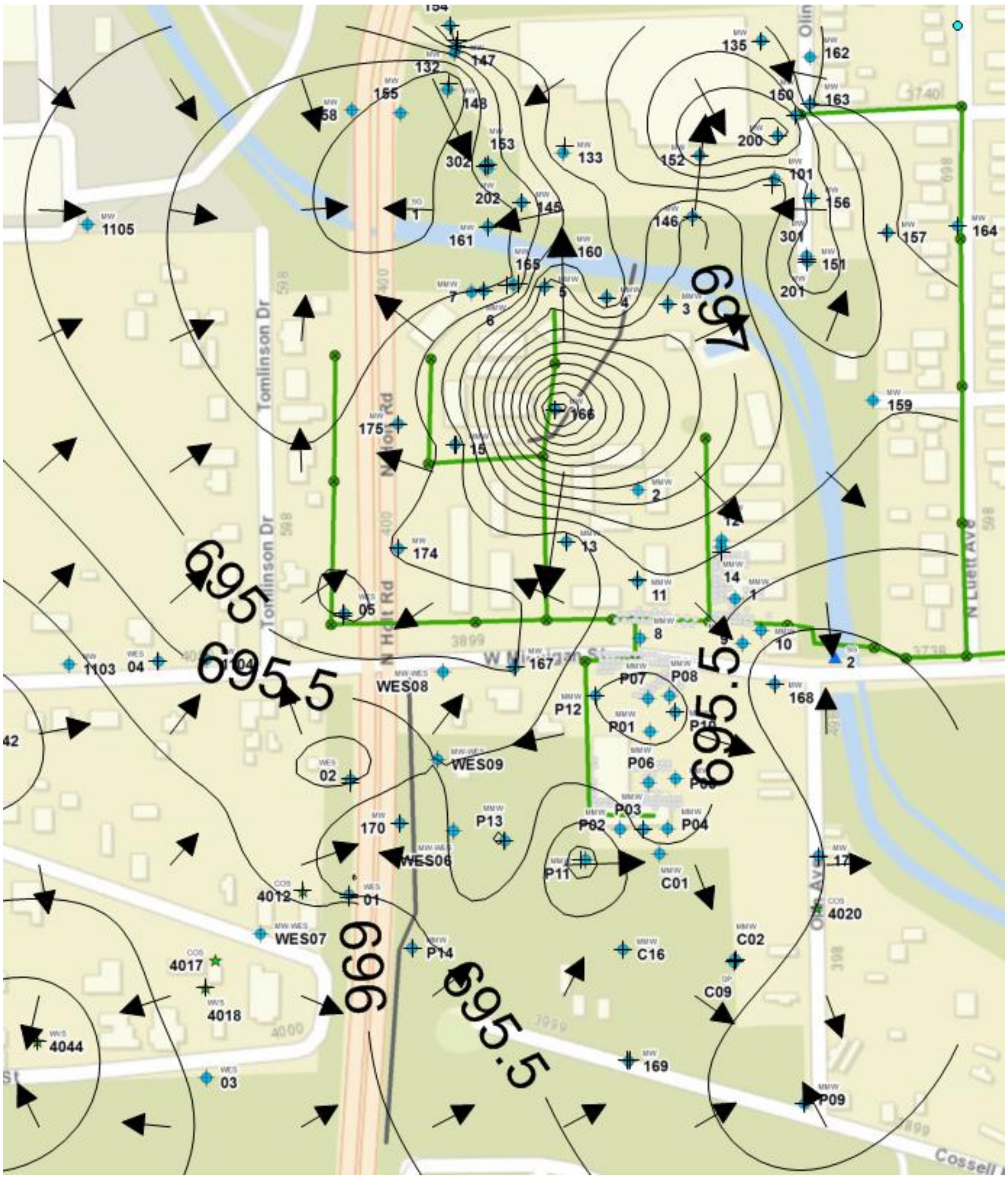


Figure 13. Intermediate Scale GWE elevation contour map for 7-30-2012 data.

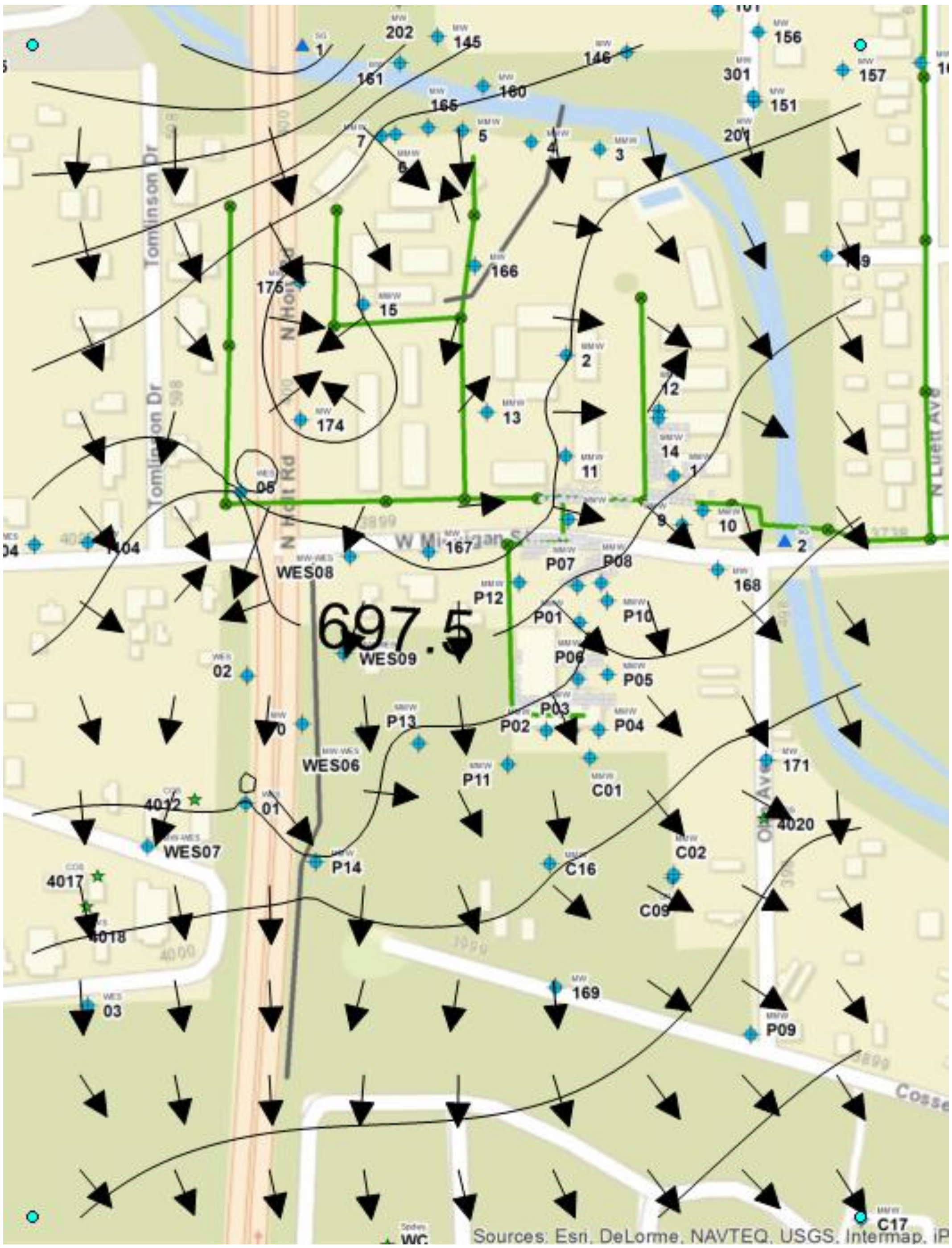


Figure 14. Intermediate Scale GWE contour for 3-01-2013 data.

Regional Scale

The Regional Scale potentiometric surface map (figure 15) was created using available monitoring well data for the region depicted on figure 1. This includes all the monitoring wells available for the region in the same aquifer. Monitoring well GWE data is from Allied Transmission, Genuine Parts, and Michigan Meadows Apartments/Plaza. The regional groundwater flow direction is predominately south and slightly southwest closer towards Eagle Creek. There is some radial flow with a southwesterly component just south of Little Eagle Creek and at the Michigan Apartments.

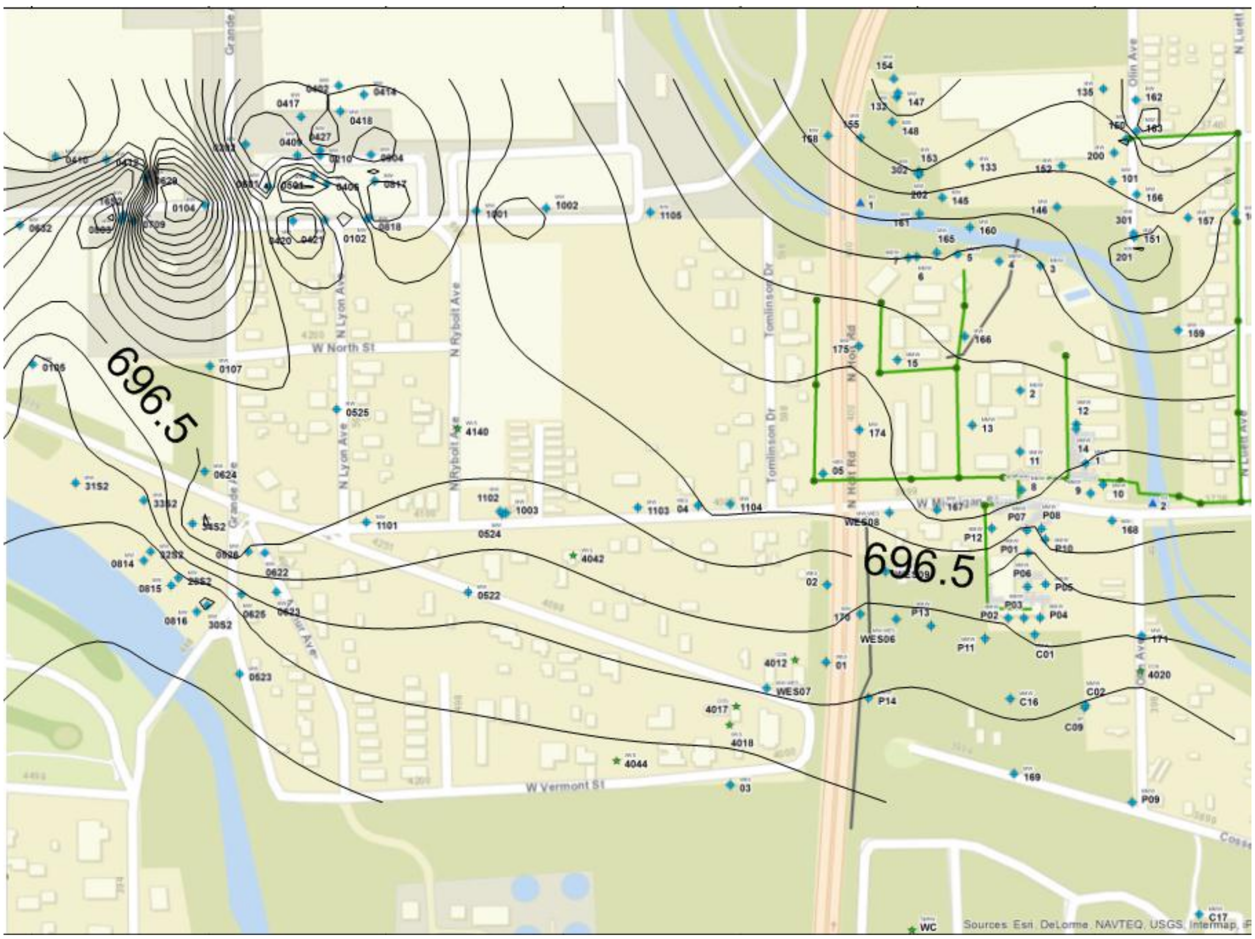


Figure15. Regional Scale Groundwater Potentiometric Surface map

Vertical Hydraulic Gradients

The effectiveness of a clay unit as an Aquitard can be assessed by understanding the vertical gradients. The intermittent, lower hydraulically conductive clays coupled with the higher conductive sands produce conditions that will impact the flow lines. The flow lines become refracted as the groundwater attempts to move through and past the lower hydraulically conductive material towards higher conductive material. The angle of refraction for groundwater moving from high to low conductivity is directed perpendicular (downwards) to the direction of flow (Fetter, 1994). Therefore, the groundwater within the sands will likely be directed vertically downwards as it comes into contact with the till/clay layer.

The greater the vertical gradient between a monitoring well screened above the clay layer and a monitoring well screened below the clay layer indicates a tighter clay as it retards the downward movement (Bradbury and others, 2006). The vertical gradients were assessed for the nested wells throughout the area. Weston installed five well clusters with shallow, intermediate, and or deep screen intervals. The screen depths were placed in sand lenses between the clay layers at monitoring wells, WES-01abc, WES-02abc, WES-04ab, WES-05abc. Only WES-01ac had the highest average vertical gradient downward at four tenths of a foot (0.41 ft). The average vertical gradient for the other WES wells were between 0.01 and 0.07 ft. The average vertical gradient at most of these wells is downwards. There are no monitoring wells screened below the entire clay, which is estimated to be about 30 feet thick towards the southwest. From this evaluation, the first 15 feet of the clay might have only a weak ability to retard groundwater flow downwards at these locations.

The vertical gradients for nested well sets were determined for the dry and wet GWE data. This was then compared to the averaged vertical gradients from the cumulative GWE data. Figure 12 and 13 show vertical gradients for the dry and wet GWE data. Upwards vertical gradients are iso-contoured in yellow. Downwards vertical gradients are iso-contoured in red. The area has a mixture of upwards and downwards vertical flow due to the underlying heterogeneity. Slightly upward vertical flow occurs along Michigan Street at nested wells MMW-11S/D, MW-167S/D, MMW-P-10S/D, MMW-P-12S/D during the dry period with little to no downward vertical flow in the other nested wells (figure 16). During wet periods, the Michigan Plaza area becomes downward (0.1-0.38) (figure 17). On average, however, upwards vertical gradients primarily occur at locations north and northeast of Michigan Street (figure 18).

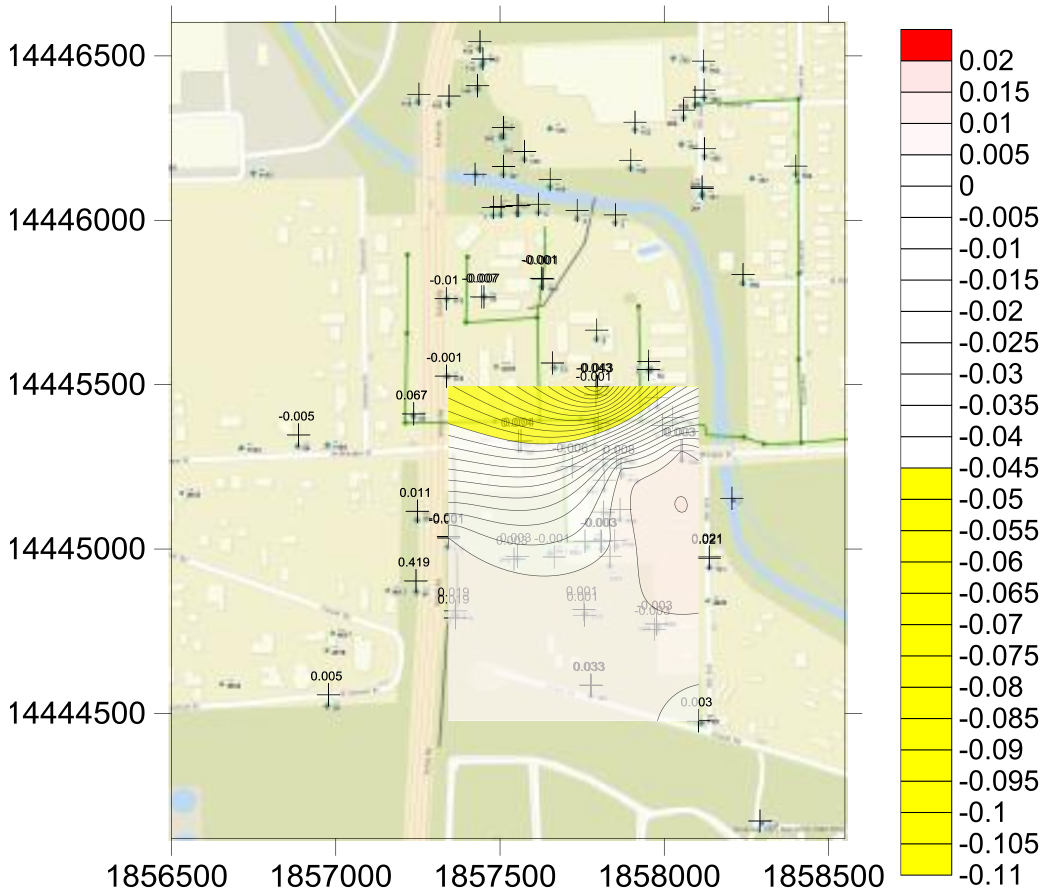


Figure 16. Dry period vertical gradient.

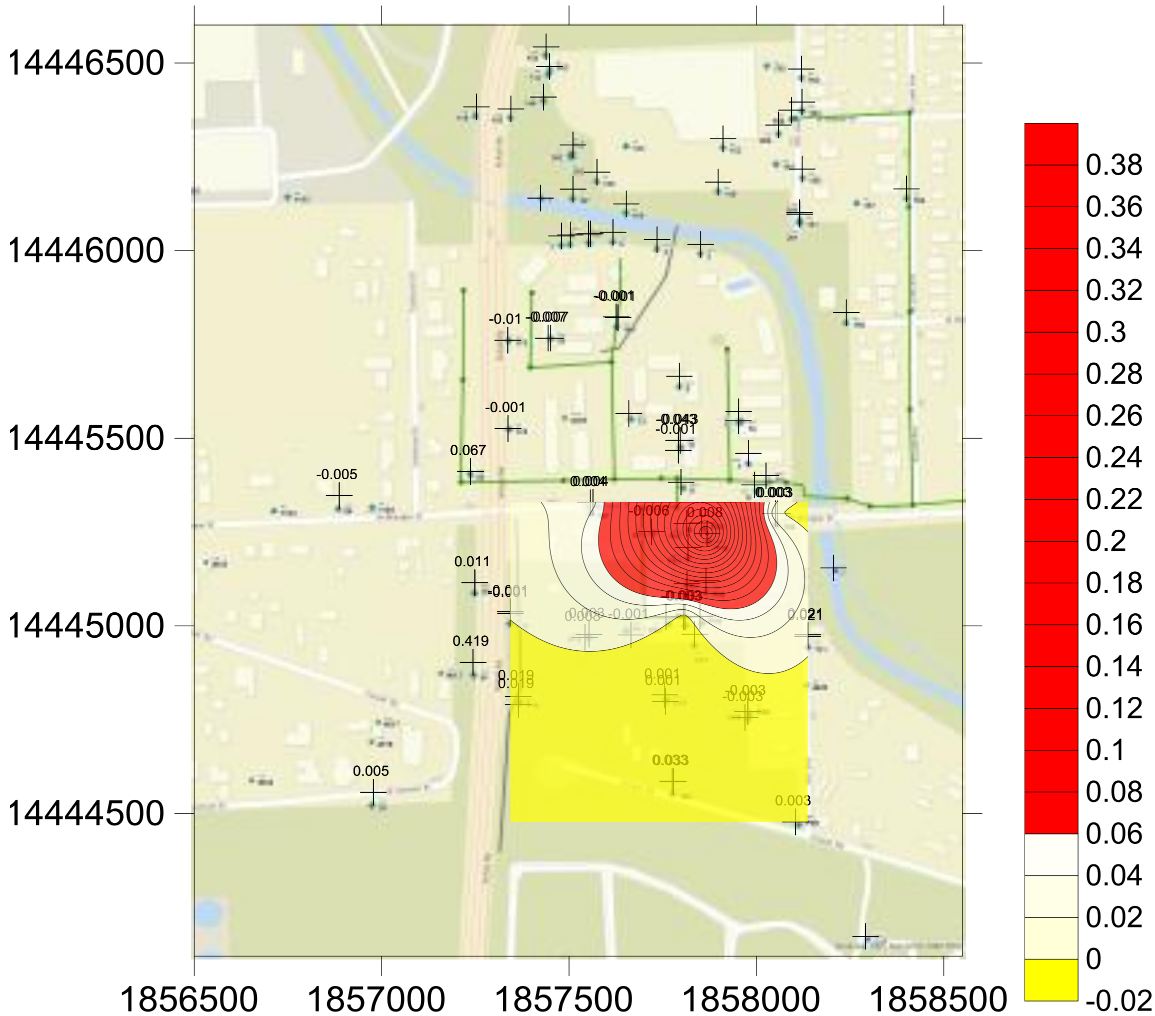


Figure 17. Wet period vertical gradient

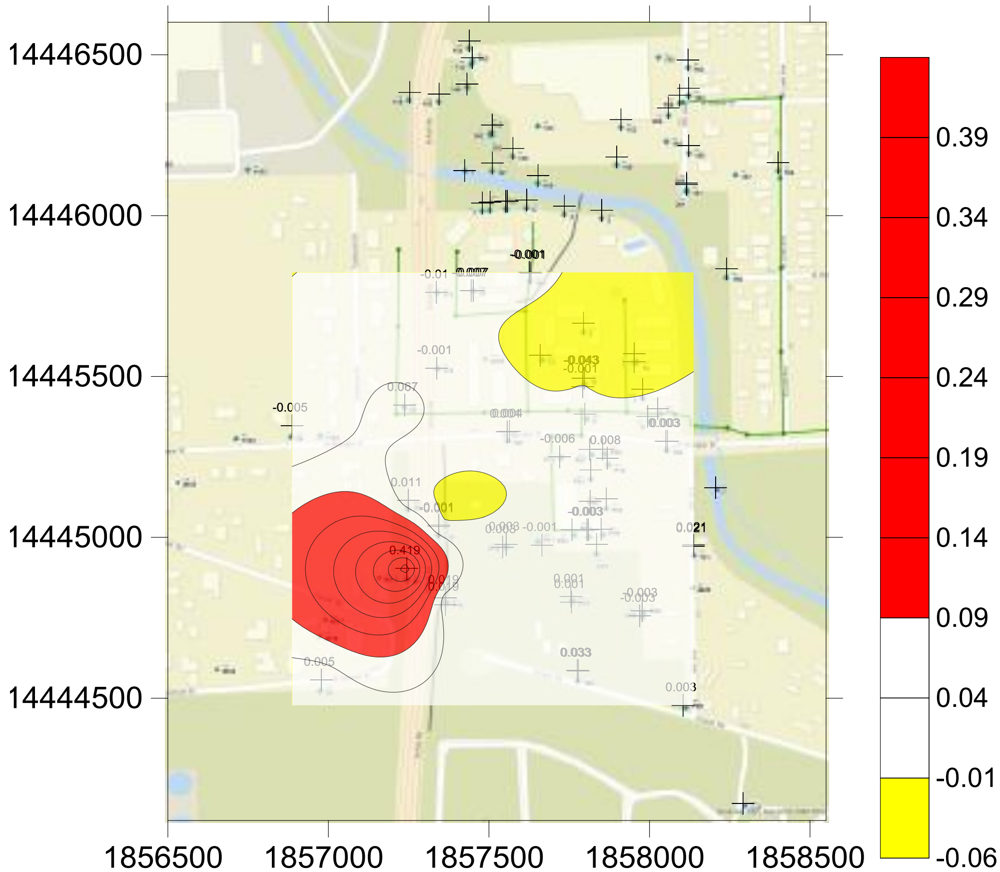


Figure 18. Averaged vertical gradients.

Localized groundwater flow has been shown to have variable spatial and temporal upward and downward vertical migration. On average, the vertical gradients are slightly upwards north of Michigan Street at Michigan Meadows Apartments and downwards near the residential wells. The upwards gradient increases during dry periods and reverses during wet periods. The area with the slightly greater downwards vertical migration could potentially direct contaminants downwards and into lower portions of the aquifer. The Weston wells have only a slight downward vertical gradient between the clay layers in that area along Holt Rd, therefore it may not be a substantial aquitard.

Water Quality Parameter (SpC)

Specific Conductance (SpC) value for seven separate periods in time were contoured to delineate possible locations of contamination and potential migration. Specific conductance is being used as a general proxy for the contaminants within the groundwater. The contaminants undergoing reductive dechlorination are steadily releasing chloride ions into the groundwater (Yu and Semprini, 2009). Conductivity increases substantially when chlorides are present (Schalk and Stasulis, 2012). The specific conductance recorded at each sampling site for each sampling year will be recording the temporal and spatial changes of specific conductivity at each well. These changes can potentially be used to delineate the plume areas and record any shifts in the plume.

The SpC iso-concentration maps are compared to PCE, VC and methane iso-concentration maps to confirm plume delineation using SpC and to potentially observe possible flow paths.

The first injection of edible oil treatment occurred around the same time as sampling (February 2007). This 2007 SpC data is the closest antecedent data available to help understand plume conditions before the edible oil treatments. The iso-concentration contours for specific conductance in 2007 indicate two separate plumes (figure 19). One plume at a separate contaminated site, Genuine Parts, and another plume underlying Michigan Plaza.

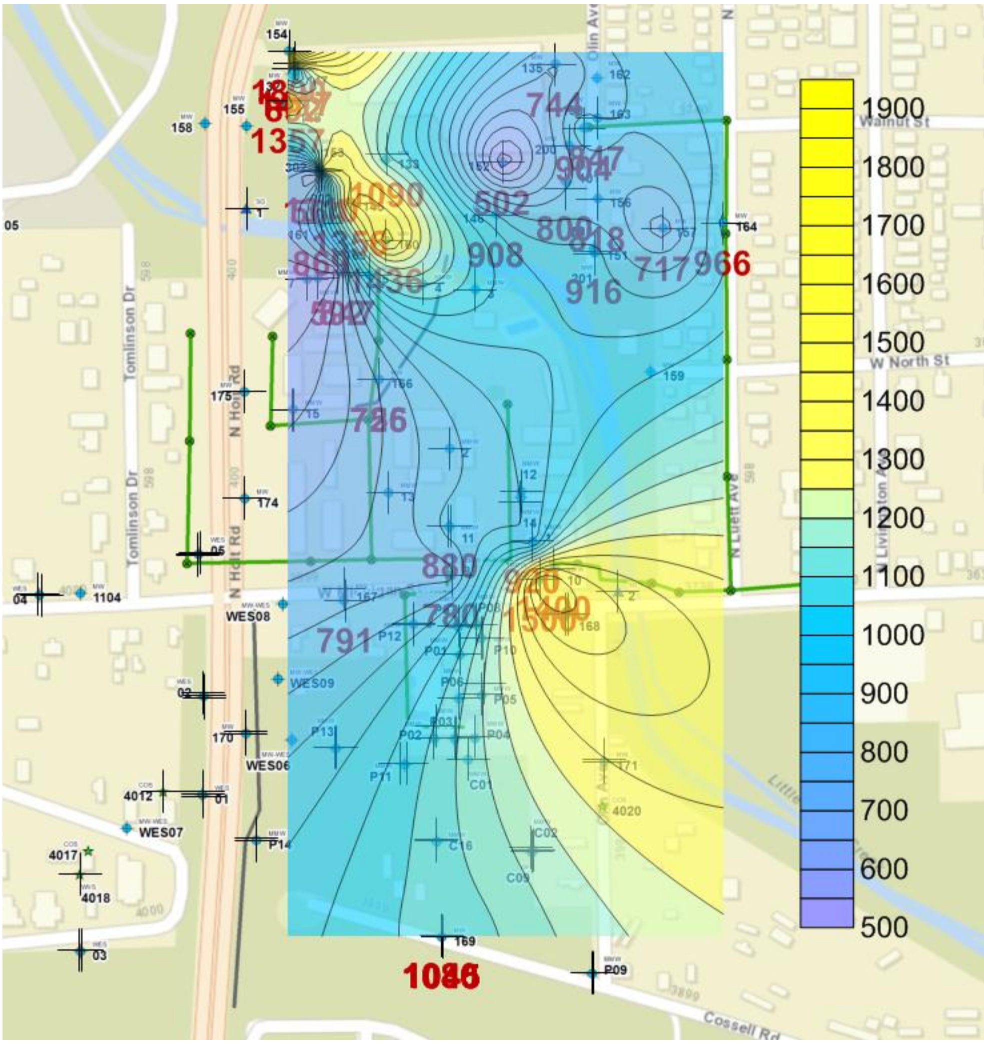


Figure 19. 2007 Specific Conductance iso-contours (SpC scale in µS/cm).

The iso-concentration contours for specific conductance in 2008 (figure 20) have highest values beneath Michigan Plaza Apartments and Michigan Plaza (3000-6000 µS/cm). There is a significant increase in specific conductance concentrations for the entire area. The high SpC value (8500 uS/cm) at the southeastern portion of the area (MW-P-9D) could be indicating an older plume migration from either Genuine Parts or Michigan Plaza or both.

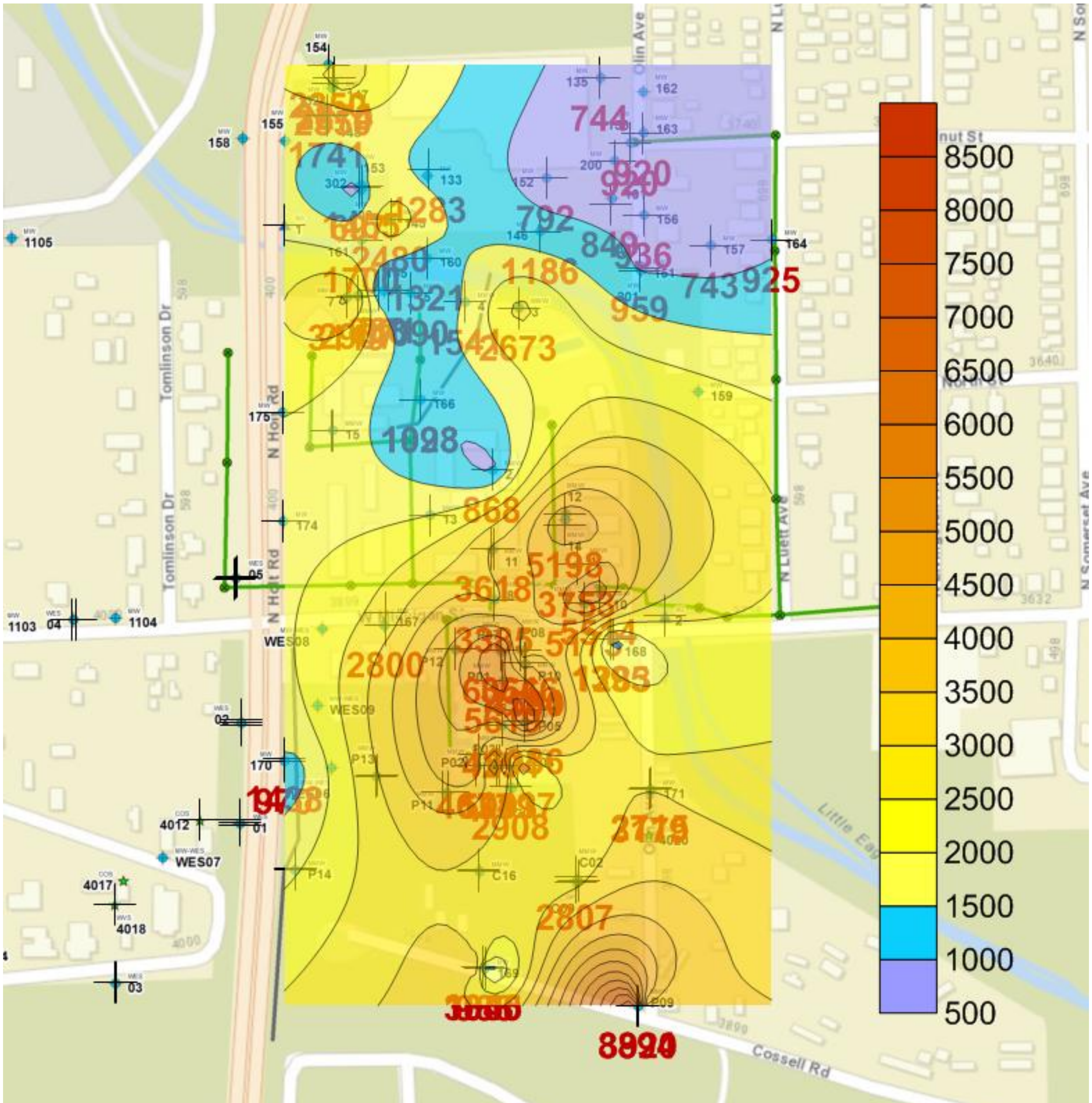


Figure 20. 2008 Specific Conductance Iso-concentration map (SpC scale in µS/cm).

Figure 21 depict the SpC iso-concentrations for 2009. The SpC iso-concentrations are higher near Genuine Parts and have a separation at Little Eagle Creek. The SpC increases at Michigan Apartments and Michigan Plaza near the source areas. There is an indication of migration towards the south and southeast.

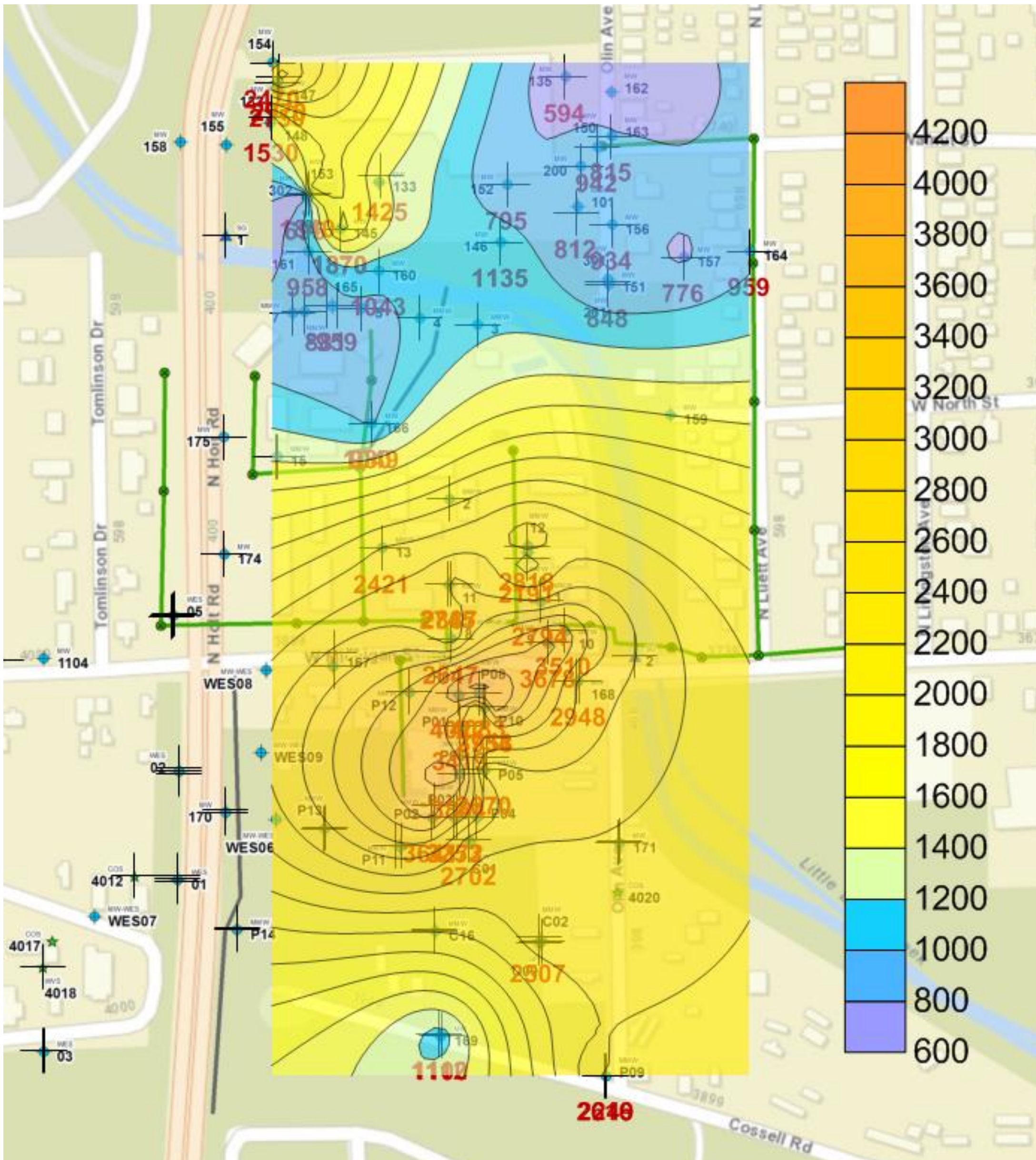


Figure21. 2009 Specific Conductance (SpC scale in µS/cm).

In 2010, (figure22) specific conductance dramatically declines to where only the highest SpC is at the source areas. There is a component of westward flow as indicated by the SpC in MW-170SD and MW-167S.

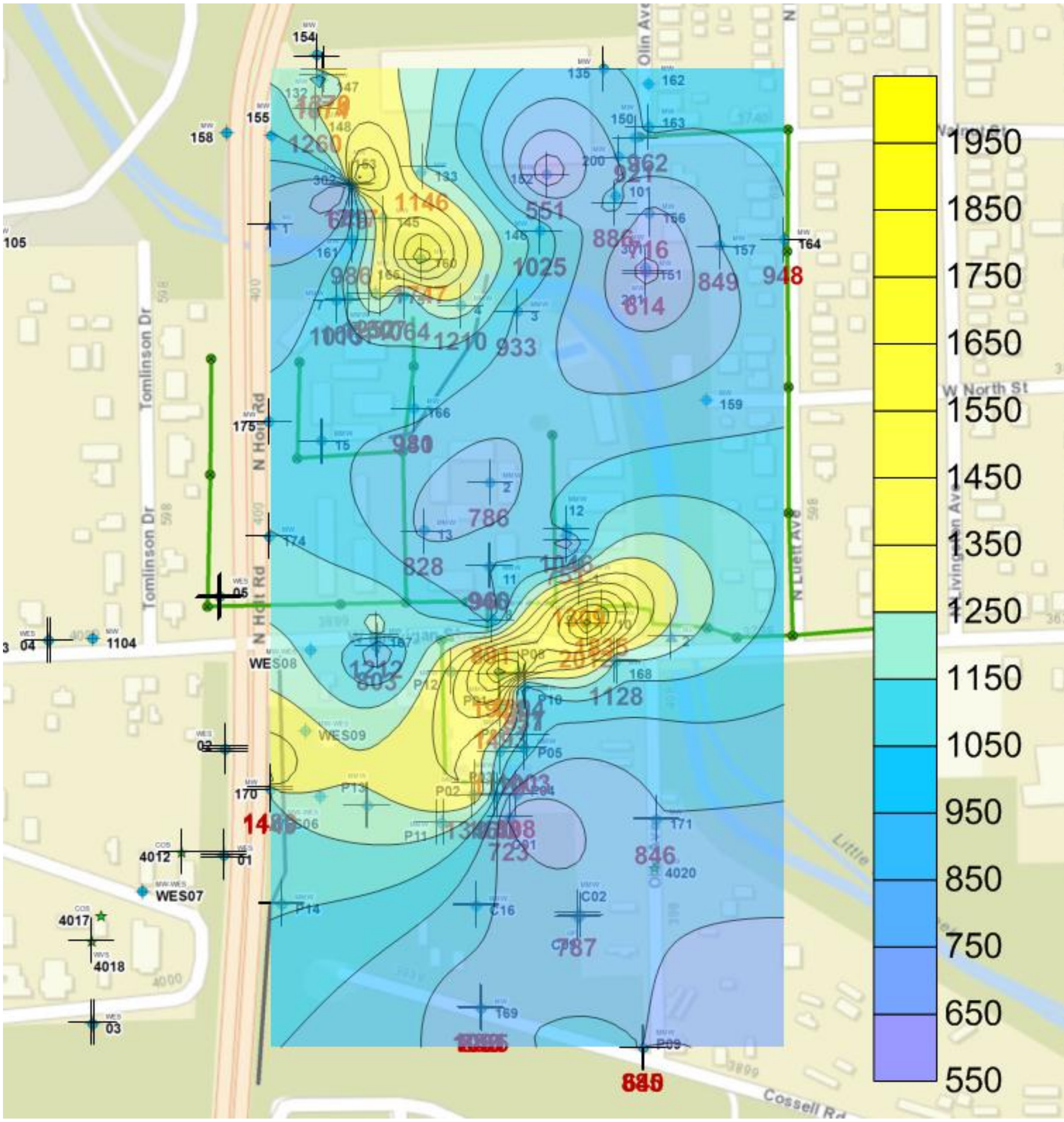


Figure22. 2010 Specific Conductance (SpC scale in µS/cm).

The iso-concentration for specific conductance in 2011 show three plume areas (figure 23). Genuine Parts to the north, Michigan Plaza on the East, and the addition of the Weston Wells completes the picture on the west, where increased SpC concentrations is found along Holt Rd and near the residential wells. The 2011 specific conductance data includes Weston's new wells near the residential area. SpC levels have decreased ~40% to a new range of 2000-3600 µS/cm. The SpC shows higher values beneath the Michigan Plaza and in the Weston wells MW-WES-02 and MW-WES-01. MW-170S had an increase in SpC from 1438 µS/cm in 2008 to 2735 µS/cm in 2011 possibly indicating a slight preferential pathway towards the west near the residential area.

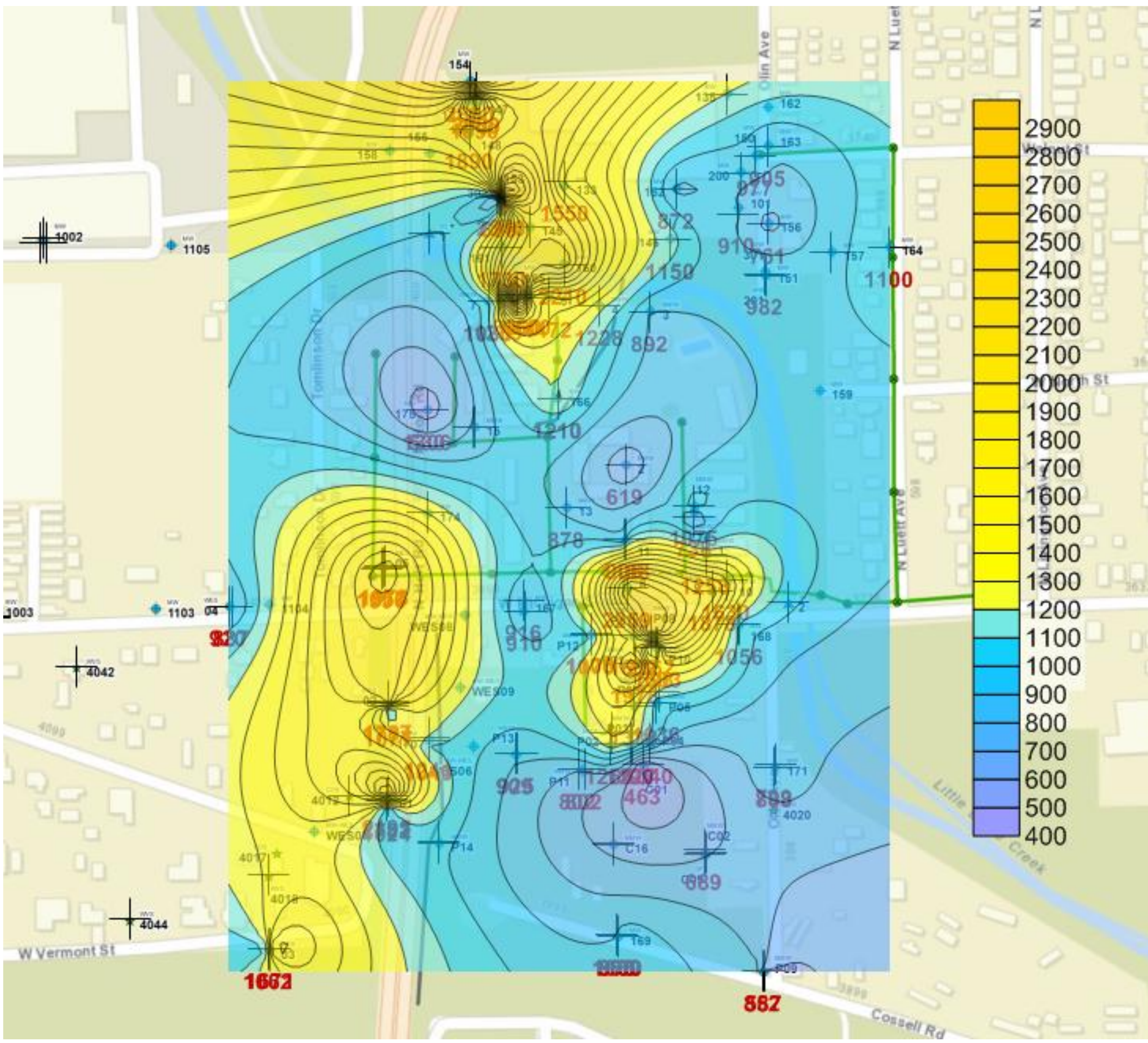


Figure 23. 2011 Specific Conductance iso-contour map (SpC scale in µS/cm).

In order to get a clear picture of what zones of the aquifer experienced the increase, the following figures show the SpC for the shallow, intermediate, and deep zones. The shallow zone indicates Michigan Plaza may have a slight westward component towards Holt Rd (figure 24).

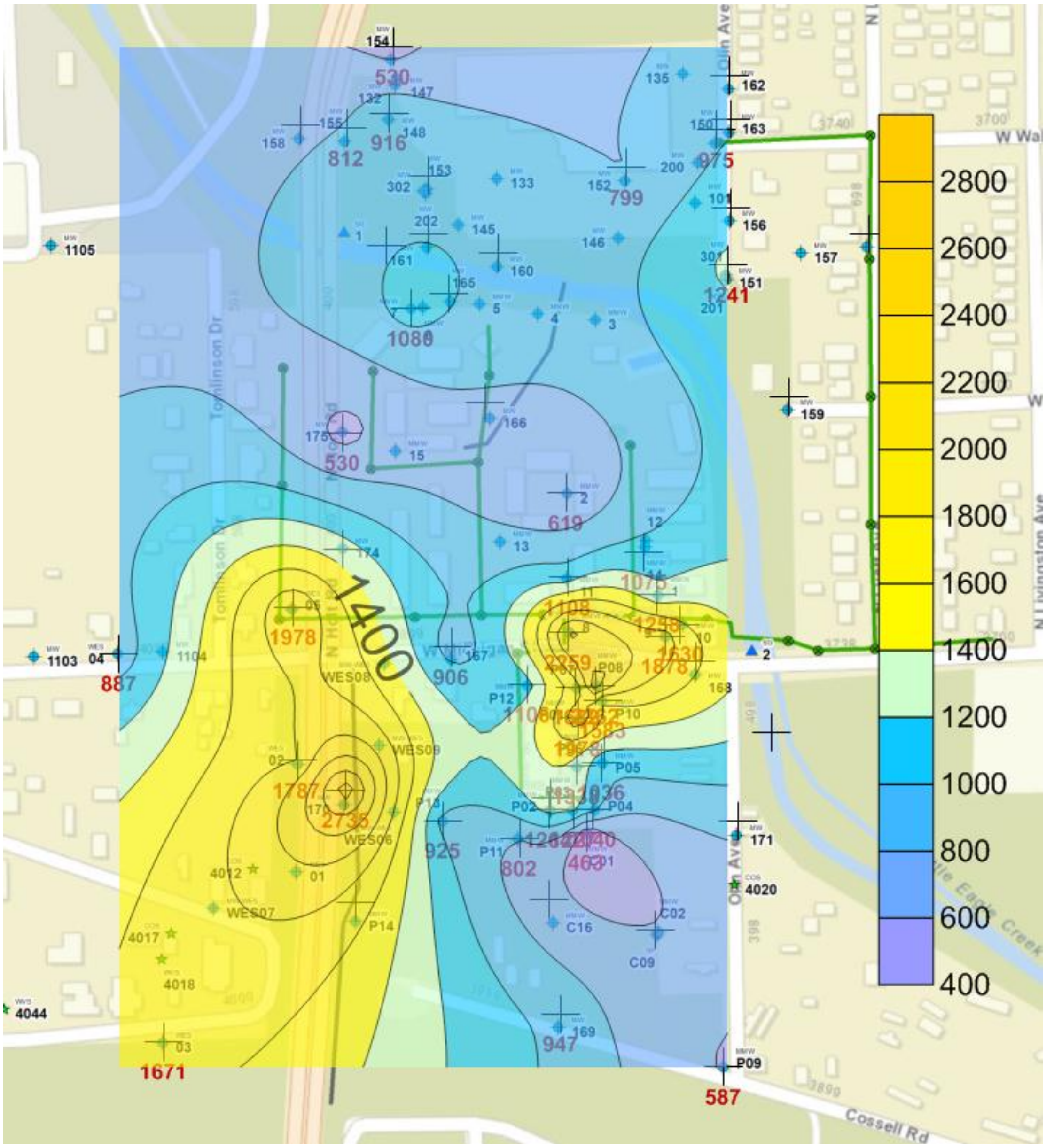


Figure 24. 2011 Shallow zone SpC iso-contour map (SpC scale in µS/cm).

Figure 25 shows the intermediate zone SpC iso-contours.

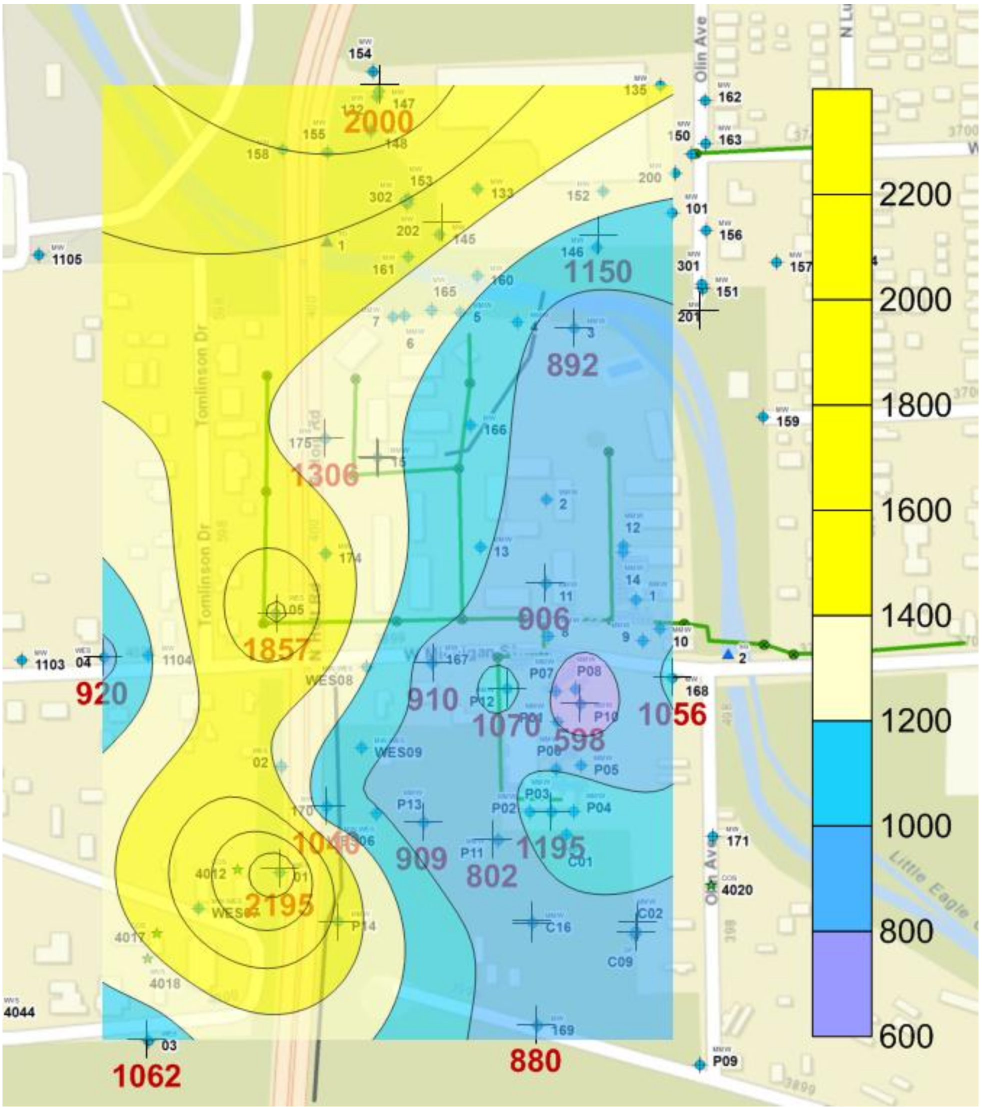


Figure25. Intermediate Zone Specific conductance iso-concentration (SpC scale in µS/cm).

It must be pointed out that the Michigan Plaza Area does not have any deep monitoring wells (<670 ft). Therefore, this presents a data gap for the deep zone of the aquifer in this area.

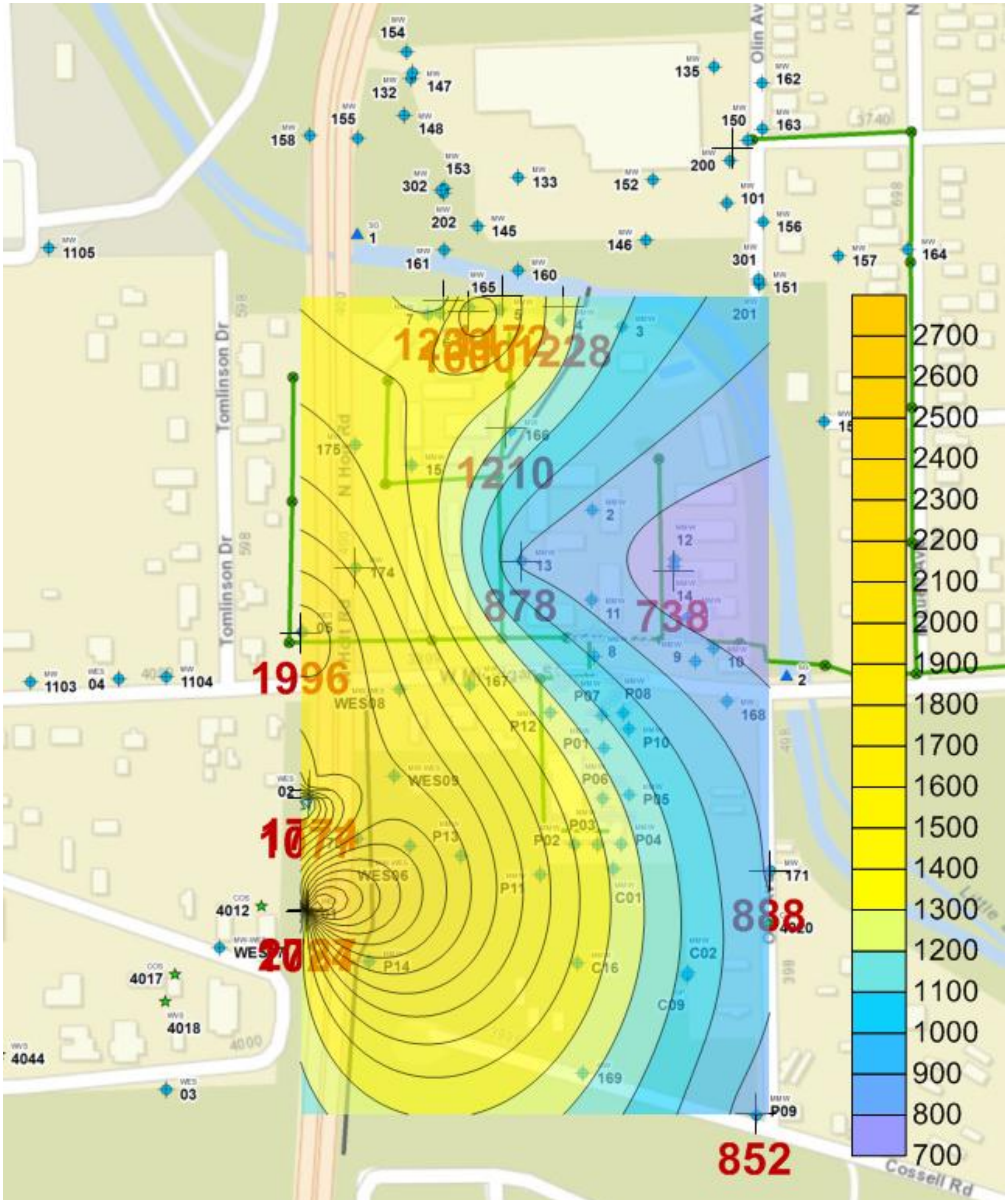


Figure 26. 2011 Deep zone specific conductance iso-concentration. Note the lack of deep monitoring wells south of Michigan Plaza (SpC scale in µS/cm).

In 2012, the newer monitoring wells (WES-xx), west of Holt Rd were not sampled. This presented a slight data gap. MW -170 S/D and P-14 are intermediate wells along the east side of Holt Rd and both were sampled in 2012. Both have elevated SpC concentrations. Figure 27 shows a general decrease in SpC concentration with the highest concentration detected at 1857 uS/cm. The areas with the highest SpC were still detected near the plume sources and also westward at MW167S and MW-170 S and D. The SpC data indicate two possible pathways, from both Genuine Parts (MW-166-D and MMW-4 D) and from Michigan Plaza (P-12-I and MW-167S).

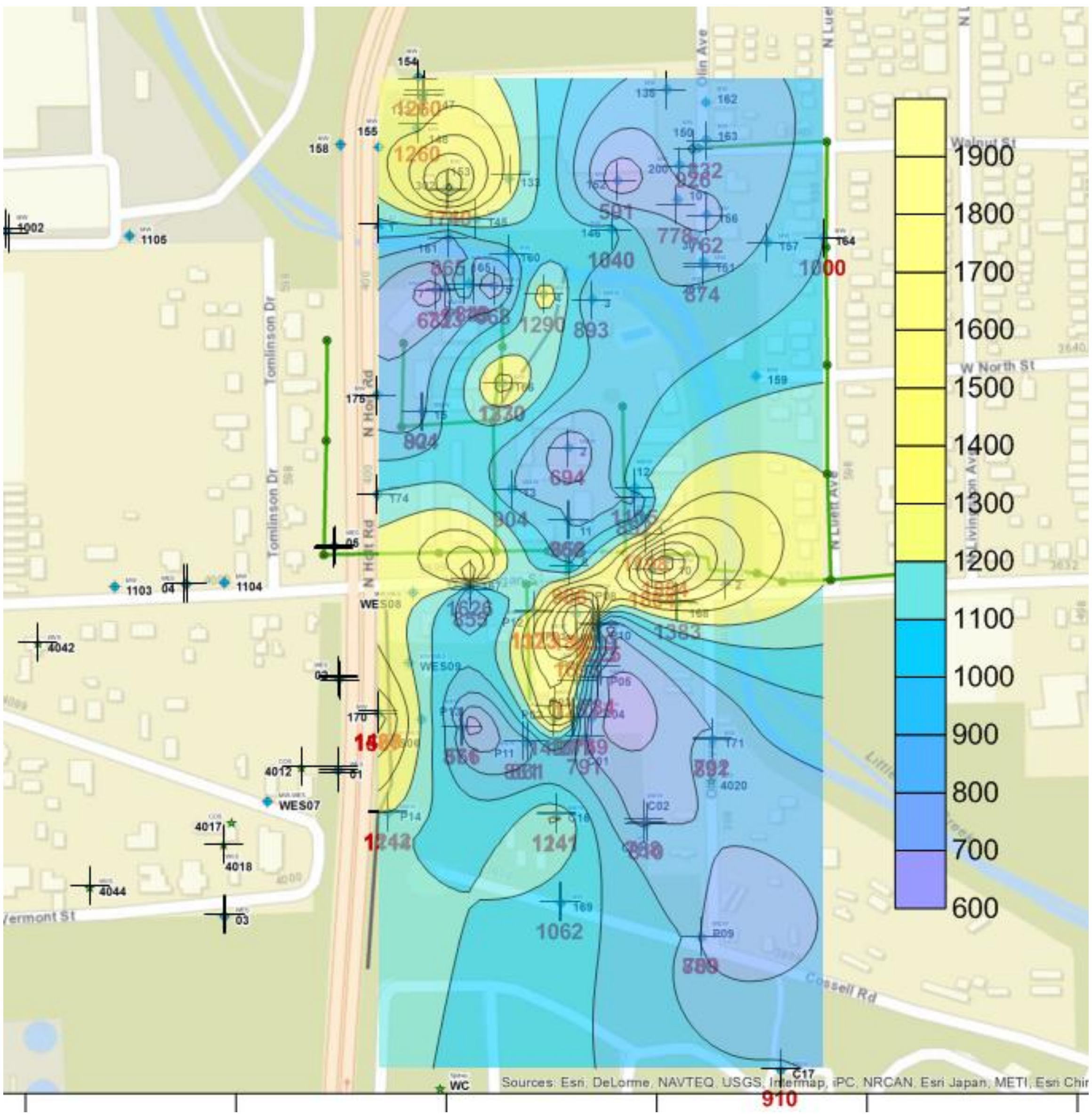


Figure 27. 2012 SpC iso-concentration map (SpC scale in µS/cm).

There are two separate figures for 2013, May and September. There have been a total of three injections of edible oil treatment to increase the rate of biodegradation. The first injection occurred in February of 2007. Another treatment occurred in August of 2009 and, more recently, in July 2013. The May 2013 (figure 28) (nearly four years post injections) and September 2013 specific conductance data is contoured to determine the effect injections may have.

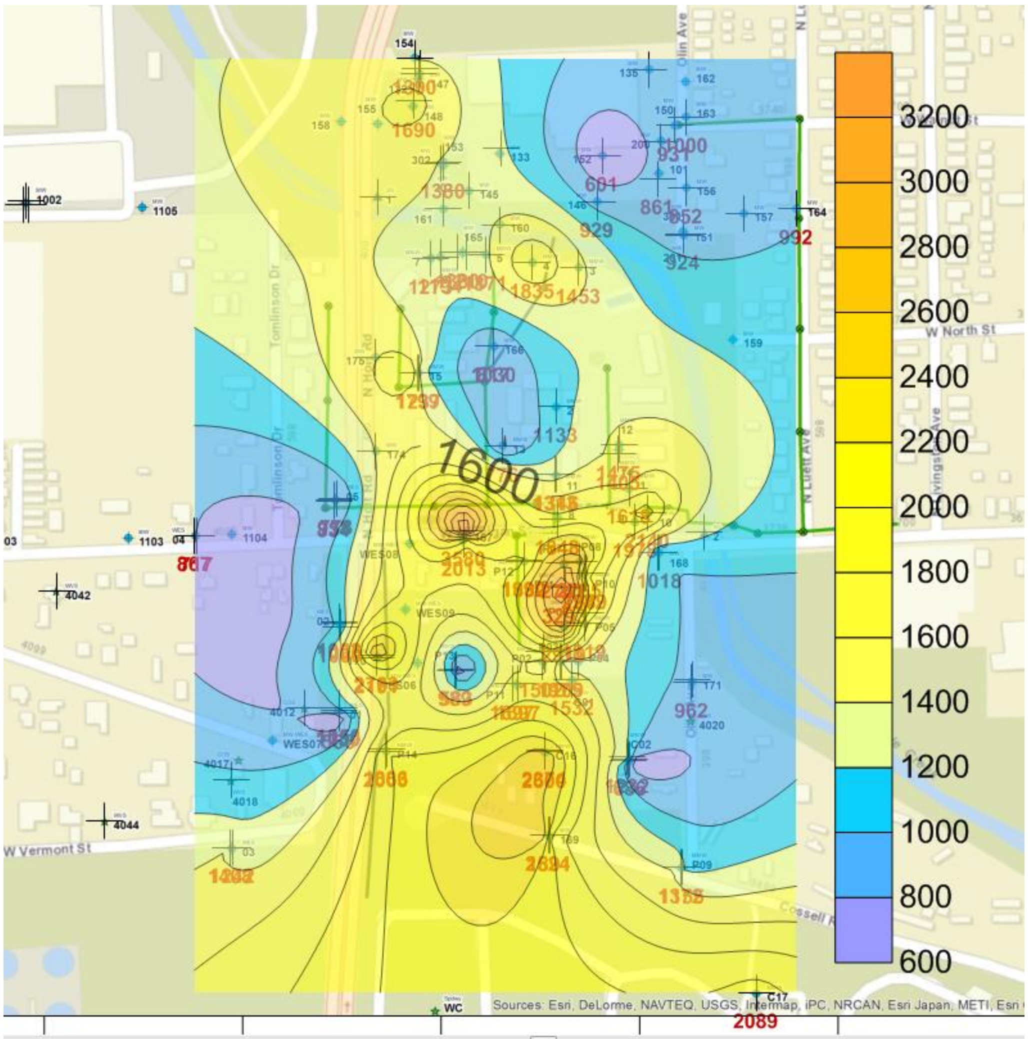


Figure 28. May 2013, SpC iso-concentration prior to edible oil injection (SpC scale in µS/cm).

Following the edible oil injections, the specific conductance decreased dramatically (figure 29). Plume areas still have elevated SpC concentration, but only between 1200 to 1900 uS/cm. There remains slightly elevated SpC along the Holt Rd monitoring wells and Weston wells. The decrease in SpC is also observed for the 2009 injections. Prior to the injections in August of 2009, the March 2009 specific conductance had been as high as 4200 uS/cm in the source areas. After the injections, the specific conductance is only as high as 2224 uS/cm at monitoring well P-07 which is directly within the source. This decrease is likely caused by the lower conductivity fluid (edible oil) mixing with the groundwater and reducing the overall conductivity of the aquifer. This decrease is followed by a slow increase in specific conductance values as the edible oil is used up by the microbes and biodegradation increases the chloride ions within the aquifer. It had taken approximately 4 years for the specific conductance to increase.

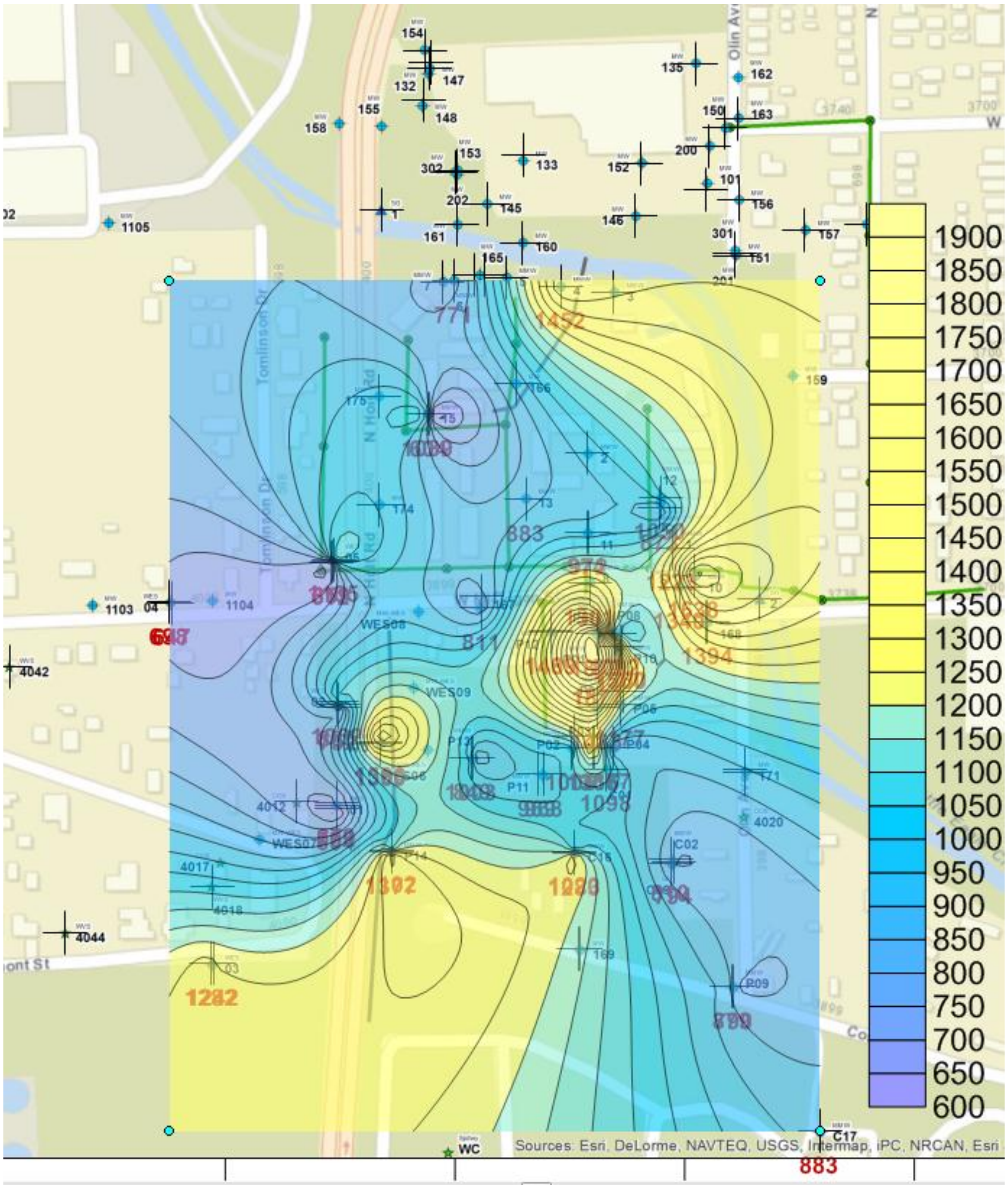


Figure 29. September 2013 SpC iso-contours, two months post edible oil injections (SpC scale in µS/cm).

Water Quality: PCE, VC and methane

Figure 30 depicts the PCE concentration detected above the MCL. PCE is detected at the Michigan Plaza and Michigan Apartments source area. It is also detected at WES-01c at a concentration of 6.0 ug/l in June 2013 and again in October 2013 at 7.4 ug/l. A residential well (RES-4044) had a one-time detection of PCE at a concentration of 3 ug/l in July of 2010. These are both deep wells (<670 ft). It is interesting to note that migration of PCE has not occurred anywhere else except towards the west. It is also important to note that there are no deep wells located at the PCE source area. The PCE has only been confirmed to be in the shallow and intermediate zones. PCE may also exist at greater depths within the source area. At 675 to 670 ft elevation, there is a clay layer with variable thickness from 5 to 30 ft. This clay layer has not been penetrated near the Michigan Plaza area, therefore the thickness and integrity is unknown.

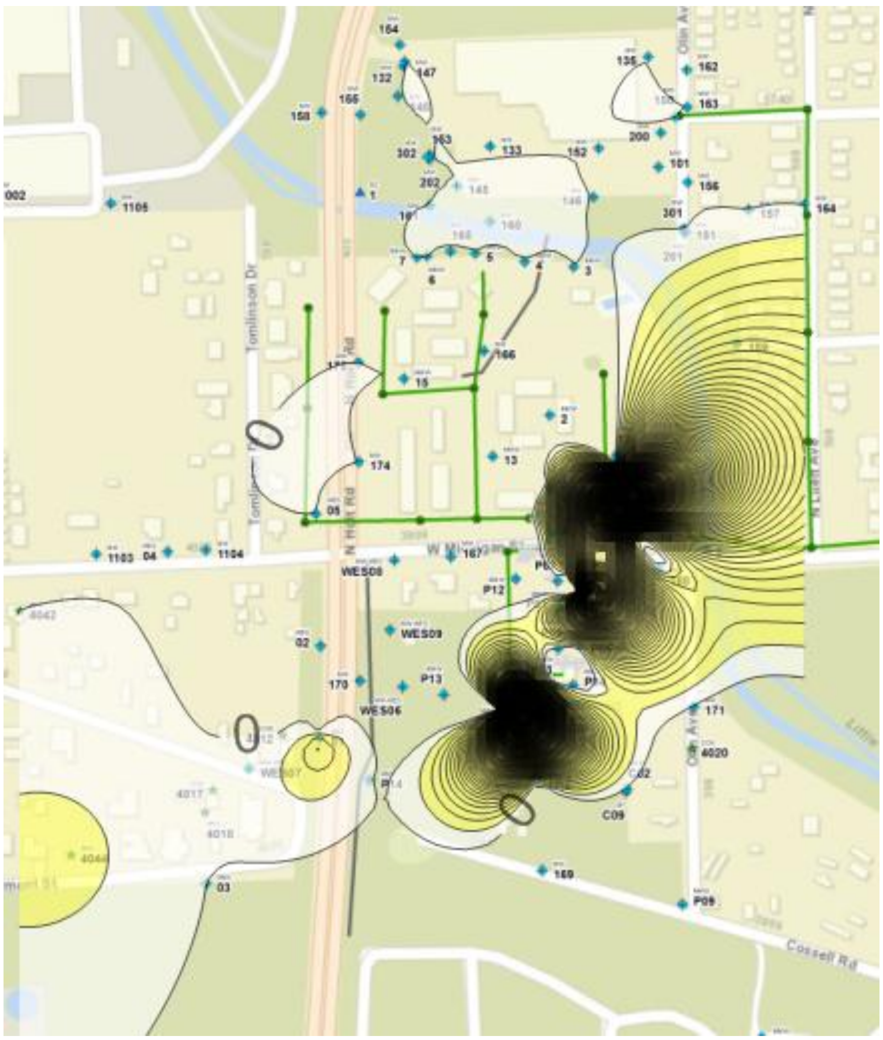


Figure 30. PCE detections above MCL (2 ug/l)

Vinyl chloride detects above the MCL (2 µg/l)are contoured in figure 31. Due to the large range in concentrations, the log (base 10) of the concentrations were contoured. The locations where there is blue and purple are non-detects. The majority of the non-detects in the southern half are all shallow monitoring wells. A migration pathway appears to follow along south and southwest at the intermediate and deep zones.

The VC iso-concentration map closely resembles the maps created with the SpC. The SpC maps depict a lack of VCs in the shallow zone along the southern half. However, a look at the individual zones (figures 24 through 26) does show higher SpC in the intermediate and deep zones and lower SpC in the shallow zone along the southeast portion of the area.

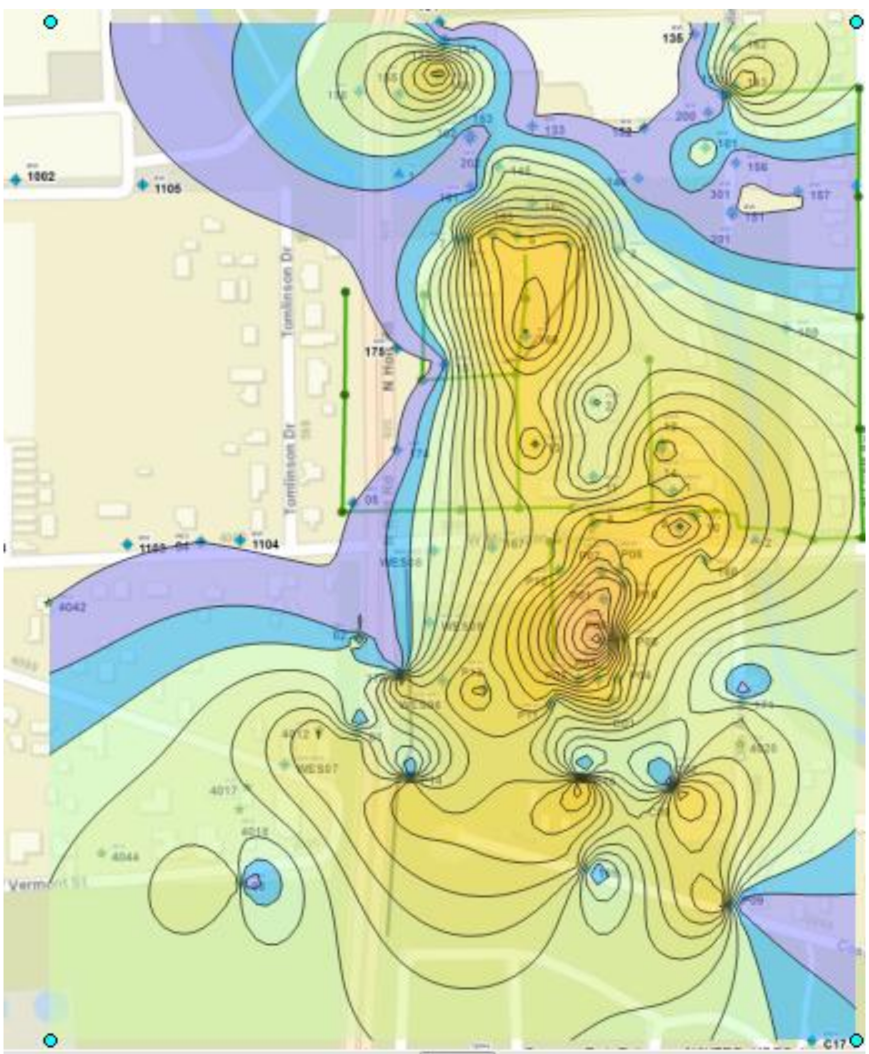


Figure 31. All Vinyl Chloride Concentration above the MCL (2 ug/l)

Methane

The addition of edible oil treatment in the Michigan Plaza and Michigan Apartments Source Areas A, B and C has created a substantial amount of methane. Concentrations of methane are highest (1,403-29,800 ug/l) at the Source Areas. Genuine Parts, historically, never tested for methane, therefore there is no information for methane concentrations on that site. EPA recently tested for methane in a few of the Genuine Parts wells and only one well (MW301) had a detection of methane at 92 µg/L. In Figure 32, the oldest available methane concentrations were contoured to try and assess conditions before the edible oil injections. Methane had not been sampled everywhere until 2013. Also, Mundell only samples a limited set of monitoring wells for dissolved methane. This creates many data gaps and limits any interpretations on the actual extent of the methane before and during 2013 sampling. Figure 32 has elevated concentrations of methane primarily at the source areas with a concentration range from 18 µg/l to 16,000 µg/l.

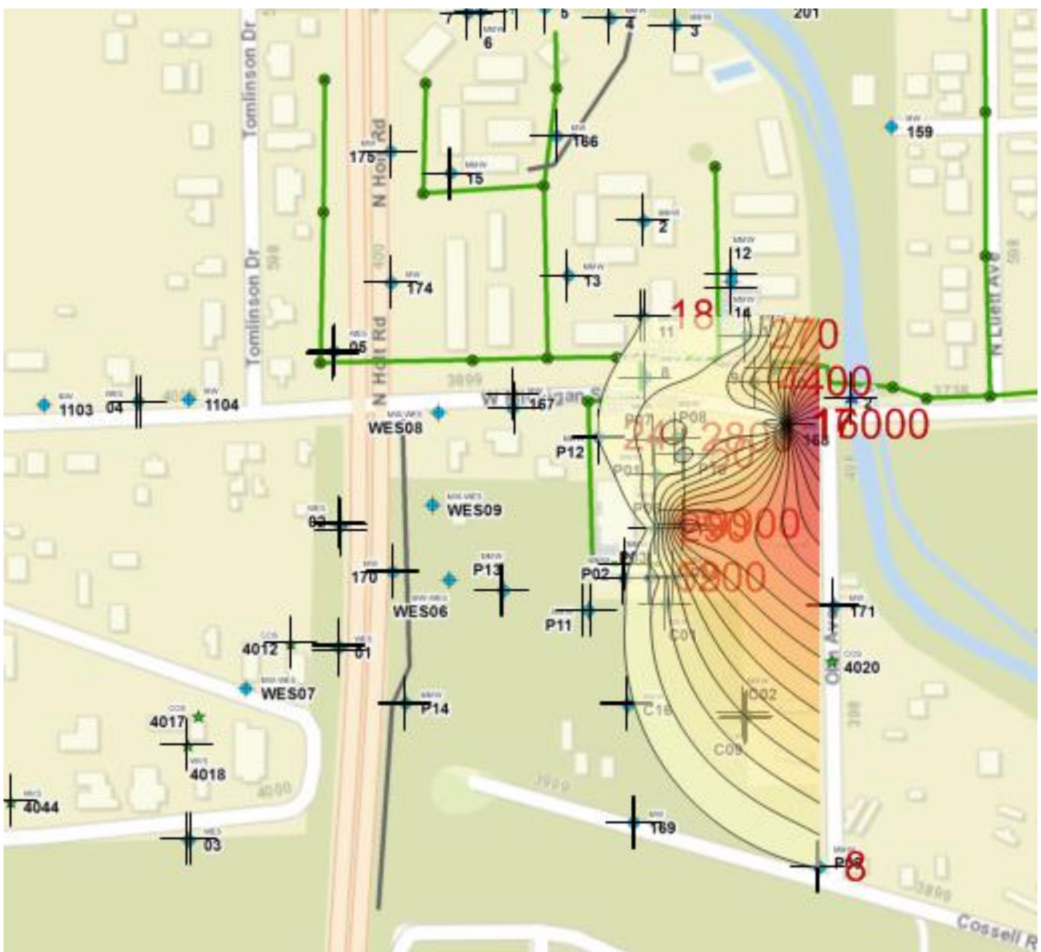


Figure 32. Oldest Available Methane concentrations for the Source Areas A, B and C.

Figures 33 through 34 show the progression of methane from 2011 through 2013. The earlier figures from 2011 and 2012 indicate an increase in methane at the source areas.

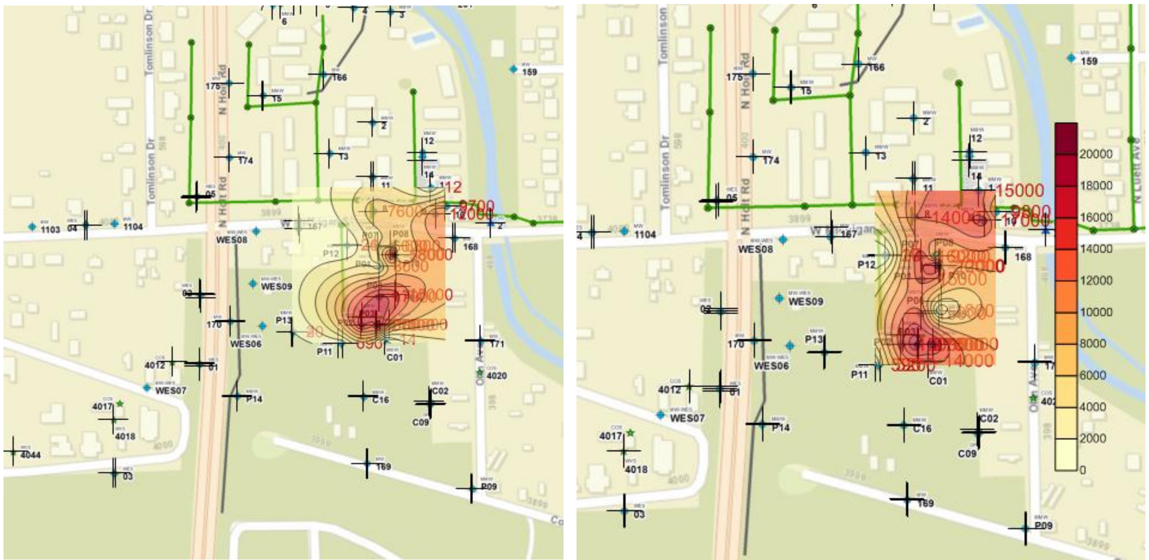


Figure 33 and 34. May 2011 Methane (left) and August 2012 Methane (right) iso-concentration maps (Methane scale is µg/l).

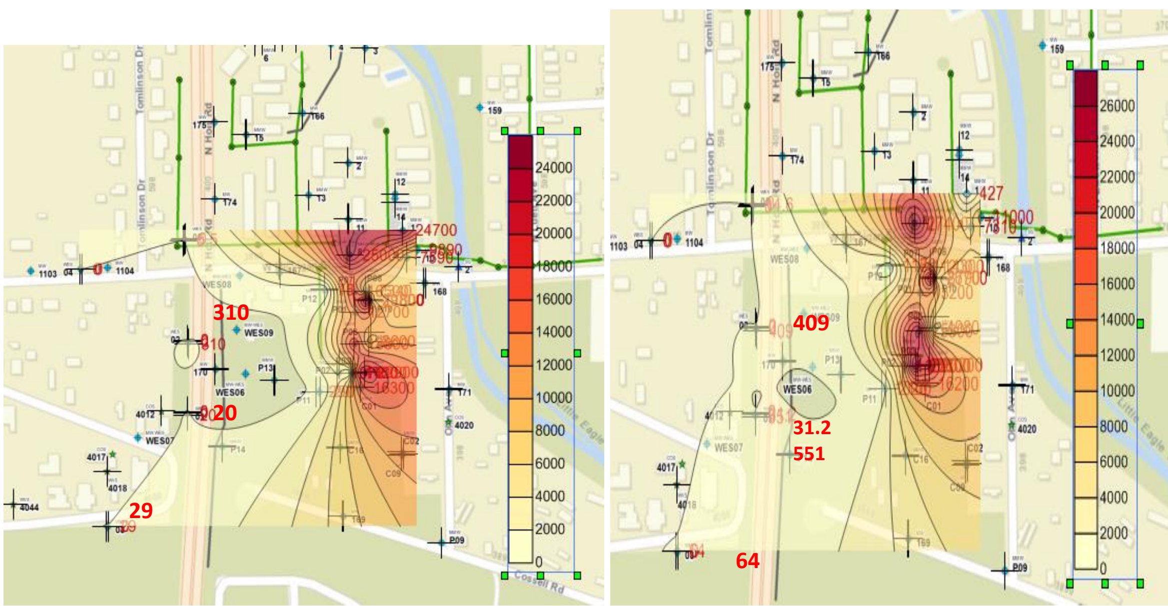


Figure 35 and 36. September 2013 Methane (left) and November 2013 Methane (right) (Methane scale is µg/l).

Figure 35 and 36 above are two methane sampling events for that year. The methane has spread westward. It is also interesting to note that the shallow wells along the west (Holt Rd) are all non-detects, but the intermediate and deep wells are showing detections. The data is still severely lacking to be able make any interpretations apart from a general increase in methane and some possible expansion westward.

Summary

The transient groundwater elevation data depicted at the local, intermediate and regional scale show evidence of some potential for a westward flow direction, particularly, north of Michigan St. The groundwater flow direction has radial flow in the shallow and intermediate aquifer zones north of Michigan Street. The flow resumes a south-southeasterly flow direction south of the Michigan Plaza area. Periods of high and low groundwater elevations have the potential to exacerbate the radial flow and shift it westward. It is not apparent that the westward flow component is a dominant preferential pathway. The vertical gradients indicate a mixture of upwards and downwards vertical flow which is attributed to the subsurface heterogeneity. The modest downward vertical gradient at the Weston monitoring wells may indicate that at least the first 15 feet of the clay is not protective enough to be considered an Aquitard.

The specific conductance is in agreement with the groundwater elevation flow path analysis, particularly at the Intermediate Scale, where some wells have increases in SpC along the radial flow near Michigan Street and along the westward component near MW-170, WES-01, and WES-02. The higher specific conductance data and detected PCE, VC and methane in some of the wells along Holt Rd and near the residential area suggest there is a pathway or a diversion of groundwater flow around the heterogeneous till and into preferential pathways along Holt Rd. The extent of this pathway towards the affected residents COS4017 and RES4018 may be limited as indicated by the slightly lower SpC when compared to the other more impacted wells. The Vinyl Chloride plume depicted is comingled with the Genuine Parts plume. Much of the data indicates that a significant amount of VC is migrating from the Genuine Parts site south along Holt Rd at the intermediate and deep zones of the aquifer. PCE and methane are detected at substantially higher concentrations at the Michigan Plaza/Apartments source areas and is possibly migrating off the Michigan Plaza along localized westward flowpaths. This preferential flowpath is made evident by the absence of detected PCE, VC and methane in the shallow wells south of the Michigan Plaza. Contaminants are only detected in the intermediate and deep wells, suggesting a preferential flow path at these elevations.

References Cited

Beodray, Frank, 2013, Technical Memorandum Analytical and Hydrogeological Evaluation West Vermont Street Site Speedway, Marion County, Indiana, Weston Solutions, Inc., Technical Direction Document No. S05-0001-1205-013

Bradbury, K,R, M.B. Gotkowitz, D.J. Hart, T.T. Eaton, J.A. Cherry, P,L. Parker, and M.A. Borchardt. 2006. Contaminant Transport Through Aquitards: Technical Guidance for Aquitard Assessment. Published by American Water Works Association (AWWA) Research Foundation, and International Water Well Association (IWA) Publishing.

Chapelle, F.H., Novak, John, Parker, John, Campbell, B.G., and Widdowson, M.A., 2007. A framework for assessing the sustainability of monitored natural attenuation: U.S. Geological Survey Circular 1303, 35 p. http://pubs.usgs.gov/circ/circ1303/pdf/circ1303.pdf

Christensen, V.G., J. Xiaodong, and A.C. Ziegler. 1999. Regression analysis and real-time water quality monitoring to estimate constituent concentrations, loads, and yields in the Little Arkansas River, South-Central Kansas, 1995-1999. U.S. Geological Survey, Water-Resources Investigations Report 00-4126.

Degnan, J.R., and Brayton, M.J., 2010, Preliminary investigation of paleochannels and groundwater specific conductance using direct-current resistivity and surface-wave seismic geophysical surveys at the Standard Chlorine of Delaware, Inc., Superfund Site, Delaware City, Delaware, 2008: U.S. Geological Survey Open-File Report 2010–1058, 27 p., at http://pubs.usgs.gov/of/2010/1058/.

Focazio, Michael J., Reilly, Thomas E., Rupert, Michaeil G., Helsel, Dennis R. 2002. Assessing Ground-Water Vulnerability to Contamination: Providing Scientifically Defensible Information for Decision Makers,. U.S. Geological Survey Circular 1224. http://pubs.usgs.gov/circ/2002/circ1224/pdf/circ1224_ver1.01.pdf

Grove, Glenn E., 2012, Potentiometric Surface Map of the Unconsolidated Aquifers of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. http://www.in.gov/dnr/water/files/19_Marion_County_UNC_PSM_map.pdf

Grove, Glenn E., 2012, Potentiometric Surface Map of the Bedrock Aquifers of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. http://www.in.gov/dnr/water/files/19_Marion_County_BED_PSM_map.pdf

Henry, Bruce. 2010. Loading Rates and Impacts of Substrate Delivery for Enhanced Anaerobic Bioremediation. Environmental Security Technology Certification Program. http://clu-in.org/download/contaminantfocus/dnapl/Treatment_Technologies/ER-0627-FR-1.pdf

ITRC (Interstate Technology & Regulatory Council). 2008. *In Situ Bioremediation of Chlorinated Ethene: DNAPL Source Zones.* BioDNAPL-3. Washington, DC: Interstate Technology & Regulatory Council, Bioremediation of DNAPLs Team www.itrcweb.org

ITRC (Interstate Technology & Regulatory Council). 1999. *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices.* Washington, D.C.: Interstate Technology & Regulatory Cooperation Work Group In-Situ Bioremediation Work Team www.itrcweb.org

Kunze, A.E. and B.N. Sroka. August 2004. Effects of highway deicing chemicals on shallow unconsolidated aquifers in Ohio—Final report. U.S. Geological Survey, Report No. FHWA/OH-2004/009.

Marin, Luis E., Steinich, B., Escolero, Oscar, Leal, Rosa Maria, Silva, Braulio, Gutierrez, Susana. 1998. Inorganic Water Quality Monitoring using Specific Conductance in Mexico, Winter GWMR, pages 156-162. http://info.ngwa.org/gwol/pdf/980263405.PDF

Prince, Keith R., Franke, O. Lehn., Reilly, Thomas E., 1988, Quantitative Assessment of the Shallow Groundwater Flow System Associated with Connetquot Brook, Long Island, New York: U.S. Geological Survey Water-Supply Paper; 2309 http://pubs.usgs.gov/wsp/2309/report.pdf

Schalk, C.W., and Stasulis, N.W., 2012, Relations among water levels, specific conductance, and depths of bedrock fractures in four road-salt-contaminated wells in Maine, 2007–9: U.S. Geological Survey Scientific Investigations Report 2012–5205, 47 p., available only at http://pubs.usgs.gov/sir/2012/5205.

Schmidt, Robert K., 2011, Unconsolidated Aquifer Systems of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. *http://www.in.gov/dnr/water/files/81_Marion_County_UNC_AQSYS_map.pdf*

Smith, Richard L., Harvey, Ronald W., LeBlanc, Denis R., 1991, Importance of closely spaced vertical sampling in delineating chemical and microbiological gradients in groundwater studies, *Journal of Contaminant Hydrology*, 7 (1991) 285-300

U.S. Geological Survey, 2010, Anoxic definition, Volatile Organic Compounds in the Nation's Ground Water and Drinking-Water Supply Wells: Supporting Information http://water.usgs.gov/nawqa/vocs/national_assessment/report/glossary.html

U.S. Geological Survey, 1995, Surface-Water-Quality Assessment of the Lower Kansaa River Basin, Kansas and Nebraska-Analysis of Available Data Through 1986. Editors P.R. Jordan and J.K. Stamer, U.S. Geological Survey Water-Supply Paper 2352-B

Winter, Thomas C., Harvey, Judson W., Franke, O. lehn, Alley, William M., 1998, Groundwater and Surface Water A Single Resource, US Geological Survey circular: 1139 http://pubs.usgs.gov/circ/circ1139/htdocs/boxg.htm

Yu, Seungho and Lewis Semprini. 2009. Enhanced reductive dechlorination of PCE DNAPL with TBOS as a slow-release electron donor. *Journal of Hazardous Materials* Vol 167, Issues 1-3, pp. 97-104. http://www.sciencedirect.com/science/article/pii/S0304389408019389

Data obtained from the following Reports/Documents:

Michigan Plaza Quarterly Monitoring Progress Report, 3rd Quarter, 2013 (October 31, 2013) Mundell Consulting Professionals for the Earth and the Environment, Mundell Project No. M01046.

Lam, Shelly (November 12, 2013) "Supporting Documentation Meeting with AIMCO" U.S. EPA Letter Report, West Vermont Drinking Water Contamination Site Indianapolis, Indiana.

2007-2011 Field Data Sheets from Keramida Environmental, INC. Genuine Parts Site Data.

Purge Logs Sept, July, June, Oct, Aug 2013 from Weston.

MW Sampling Logs 12072011 through 12122011 from Weston.

Tables in 09272013 Remediation Work Plan from Mundell.

AIMCO-Mundell Technical Response to EPA January 2013 Technical Memorandum April 18, 2013.

Appendix

Table 1-1. Monitoring Well Construction Data

Monitoring Well	**Site/well owner**	**x**	**y**	**Top of Casing Elevation**	**Depth to Top of Screen**	**Depth to Bottom of Screen**	**Total Depth**	**Top of Screen Elevation**	**Bottom of Screen Elevation**	**Aquifer Zone**
MW-WES-01a	USEPA	1857244	14444903	716.13	32.5	37.5	37.5	683.63	678.63	I
MW-WES-01b	USEPA	1857244	14444903	716.05	41	46	46	675.05	670.05	D
MW-WES-01c	USEPA	1857244	14444903	715.96	50	55	55	665.96	660.96	D
MW-WES-02a	USEPA	1857249	14445115	716.24	24	29	29	692.24	687.24	S
MW-WES-02b	USEPA	1857249	14445115	716.28	35	40	40	681.28	676.28	D
MW-WES-02c	USEPA	1857249	14445115	716.23	40	50	50	676.23	666.23	D
MW-WES-03a	USEPA	1856978	14444557	717.42	30	35	35	687.42	682.42	S
MW-WES-03b	USEPA	1856978	14444557	717.41	40	45	45	677.41	672.41	I
MW-WES-04a	USEPA	1856887	14445347	717.85	30	35	35	687.85	682.85	S
MW-WES-04b	USEPA	1856887	14445347	717.85	40	45	45	677.85	672.85	I
MW-WES-05a	USEPA	1857237	14445411	717.04	20	25	25	697.04	692.04	S
MW-WES-05b	USEPA	1857237	14445411	716.6	32.5	37.5	37.5	684.1	679.1	I
MW-WES-05c	USEPA	1857237	14445411	715.95	45	50	50	670.95	665.95	D
MMW-10S	Michigan Plaza	1858026	14445400	712.69	15	25	25	697.69	687.69	S
MMW-11D	Michigan Plaza	1857792	14445494	713.33	23	33	36	690.33	680.33	I
MMW-11S	Michigan Plaza	1857797	14445494	713.17	14	24	24	699.17	689.17	S
MMW-12S	Michigan Plaza	1857953	14445571	712.15	14	24	24	698.15	688.15	S
MMW-13D	Michigan Plaza	1857659	14445566	713.28	35	50	50	678.28	663.28	D
MMW-14D	Michigan Plaza	1857952	14445546	712.41	40	50	50	672.41	662.41	D
MMW-1S	Michigan Plaza	1857979	14445460	712.92	10	20	20	702.92	692.92	S
MMW-2S	Michigan Plaza	1857794	14445666	712.95	10	20	20	702.95	692.95	S
MMW-3S	Michigan Plaza	1857851	14446017	710.2	20	30	30	690.2	680.2	I

MMW-4D	Michigan Plaza	1857735	14446029	711.29	56	66	66	655.29	645.29	D
MMW-5D	Michigan Plaza	1857618	14446049	711.27	41	51	51	670.27	660.27	D
MMW-6D	Michigan Plaza	1857503	14446042	712.4	41	51	51	671.4	661.4	D
MMW-7S	Michigan Plaza	1857480	14446039	712.09	16	26	26	696.09	686.09	S
MMW-8S	Michigan Plaza	1857799	14445383	714.24	14	24	24	700.24	690.24	S
MMW-9S	Michigan Plaza	1857995	14445376	713.71	15	25	25	698.71	688.71	S
MMW-C-01	Michigan Plaza	1857835	14444978	715.73	18	28	28	697.73	687.73	S
MMW-C-02	Michigan Plaza	1857977	14444772	714.64	18	28	28	696.64	686.64	S
MMW-P-01	Michigan Plaza	1857817	14445209	715.26	18	28	28	697.26	687.26	S
MMW-P-02	Michigan Plaza	1857759	14445024	716.09	20	30	30	696.09	686.09	S
GP-02	Michigan Plaza	1857759	14445024	716.09	20	30	30	696.09	686.09	S
MMW-P-03D	Michigan Plaza	1857805	14445024	716.02	25	35	40	691.02	681.02	I
MMW-P-03S	Michigan Plaza	1857809	14445024	715.95	18	28	28	697.95	687.95	S
MMW-P-04	Michigan Plaza	1857849	14445025	716.04	18	28	20	698.04	688.04	S
MMW-P-05	Michigan Plaza	1857866	14445120	715.55	18	28	28	697.55	687.55	S
GP-05	Michigan Plaza	1857866	14445120	715.55	18	28	28	697.55	687.55	S
MMW-P-06	Michigan Plaza	1857815	14445112	716.14	18	28	28	698.14	688.14	S
MMW-P-07	Michigan Plaza	1857814	14445273	714.9	18	28	28	696.9	686.9	S
MMW-P-08	Michigan Plaza	1857854	14445274	714.53	18	28	28	696.53	686.53	S
MMW-P-09D	Michigan Plaza	1858104	14444478	714.82	35	45	45	679.82	669.82	D
MMW-P-09S	Michigan Plaza	1858104	14444478	714.8	18	28	28	696.8	686.8	S
MMW-P-10D	Michigan Plaza	1857869	14445246	714.42	28	38	38	686.42	676.42	I
MMW-P-10S	Michigan Plaza	1857869	14445246	714.35	18	28	28	696.35	686.35	S
MMW-P-11S	Michigan Plaza	1857792	14445468	716.42	16	26	26.65	700.42	690.42	S
MMW-P-11D	Michigan Plaza	1857792	14445468	716.42	16	26	26.65	700.42	690.42	S
MMW-P-12D	Michigan Plaza	1857720	14445251	715.33	31.5	36.5	36.5	683.83	678.83	I
MMW-P-12S	Michigan Plaza	1857720	14445251	715.83	16	26	26	699.83	689.83	S
MMW-P-13D	Michigan Plaza	1857543	14444969	713.57	28	33	33	685.57	680.57	I
MMW-P-13S	Michigan Plaza	18575	144449	713.83	16	26	26	697.83	687.83	S

		54	78							
MW-0102-S2	Allison Transmission	1855955	14446148	717.22						S
MW-0104-S2	Allison Transmission	1855497	14446188	719.28						S
MW-0105-S2	Allison Transmission	1855013	14445739	721.03						S
MW-0106-S2A	Allison Transmission	1854810	14445813	721.48						S
MW-0107-S2	Allison Transmission	1855511	14445734	719.64						S
MW-0116-S2	Allison Transmission	1854591	14445705	721.69						S
MW-0202-S2A	Allison Transmission	1855611	14446355	718.59						S
MW-0202-S2B	Allison Transmission	1855612	14446358	718.72						D
MW-0202-S3	Allison Transmission	1855612	14446363	718.48						D
MW-0210-S3	Allison Transmission	1855821	14446326	718.22						D
MW-0402-S3	Allison Transmission	1855869	14446498	719.61	45	52	52	674.61	667.61	D
MW-0406-S2B	Allison Transmission	1855841	14446248	717.25						D
MW-0409-S2B	Allison Transmission	1855757	14446328	718.29						D
MW-0410-S2	Allison Transmission	1855077	14446324	721.74						S
MW-0412-S2	Allison Transmission	1855219	14446316	721.98						S
MW-0414-S2A	Allison Transmission	1855940	14446472	719.67	30	40	40	689.67	679.67	D
MW-0414-S3	Allison Transmission	1855940	14446472	719.58	35	43	43	684.58	676.58	D
MW-0417-S3	Allison Transmission	1855763	14446410	719.47	45	54	54	674.47	665.47	D
MW-0418-S2A	Allison Transmission	1855867	14446426	718.66	19	29	29	699.66	689.66	D
MW-0418-S3	Allison Transmission	1855879	14446425	719.17	45	52	52	674.17	667.17	D
MW-0420-S3	Allison Transmission	1855745	14446143	718.9						D
MW-0421-S2A	Allison Transmission	1855839	14446146	717.72						S
MW-0421-S3	Allison Transmission	1855832	14446145	717.68						D
MW-0427-S2B	Allison Transmission	1855822	14446342	718.19	27	39	39	691.19	679.19	D
MW-0522-S2A	Allison Transmission	1856236	14445098	719.38			28			S
MW-0522-S2B	Allison Transmission	1856241	14445097	719.35			44			S
MW-0523-S2	Allison Transmission	1855594	14444867	721.7						S
MW-0524-S2A	Allison Transmission	1856334	14445318	719.78			26.25			S

MW-0524-S2B	Allison Transmission	1856337	14445315	719.71			42			D
MW-0525-S2	Allison Transmission	1855868	14445613	719.64						S
MW-0526-S2A	Allison Transmission	1855617	14445212	719.86						S
MW-0526-S2B	Allison Transmission	1855622	14445212	720.38						D
MW-0622-S2A	Allison Transmission	1855665	14445208	720						S
MW-0623-S2A	Allison Transmission	1855699	14445098	718.93						S
MW-0624-S2	Allison Transmission	1855496	14445438	721.38						S
MW-0625-S2A	Allison Transmission	1855601	14445091	720.43						S
MW-0629-S2	Allison Transmission	1855333	14446265	721.46						S
MW-0629-S3	Allison Transmission	1855325	14446265	721.45						D
MW-0632-S2	Allison Transmission	1854976	14446132	720.5						S
MW-0709-S2	Allison Transmission	1855295	14446142	719.68						S
MW-0803-S2	Allison Transmission	1855261	14446144	720.2						S
MW-0814-S2	Allison Transmission	1855325	14445187	722.13						S
MW-0815-S2	Allison Transmission	1855403	14445116	721.91						S
MW-0816-S2	Allison Transmission	1855475	14445042	721.8						S
MW-0817-S2B	Allison Transmission	1855975	14446259	717.08						D
MW-0817-S3	Allison Transmission	1855975	14446252	717						D
MW-0818-S3	Allison Transmission	1855960	14446152	717.82						D
MW-0904-S3	Allison Transmission	1855965	14446330	718.2						D
MW-1001-S2B	Allison Transmission	1856268	14446171	717.61						D
MW-1001-S3	Allison Transmission	1856254	14446171	717.4						D
MW-1002-S2B	Allison Transmission	1856452	14446174	717.05						D
MW-1002-S3	Allison Transmission	1856465	14446176	717.41						D
MW-1002-S3-4	Allison Transmission	1856459	14446185	716.05						D
MW-1003-S3	Allison Transmission	1856341	14445294				55			S
MW-16-S2	Allison Transmission	1855269	14446161	720.28						S
MW-28-S2	Allison Transmission	1855422	14445137	722.09						S
MW-30-S2	Allison	18555	144450	720.89						S

	Transmission	04	60							
MW-31-S2	Allison Transmission	1855132	14445405	720.77						S
MW-32-S2	Allison Transmission	1855344	14445212	722.15						S
MW-33-S2	Allison Transmission	1855325	14445356	720.48						S
MW-34-S2	Allison Transmission	1855462	14445291	720.5						S
MW-3-9-S2	Allison Transmission	1854106	14445973	723.42						S
MW-S2-0601	Allison Transmission	1855680	14446239	718.03						S
MW-S2A-0501	Allison Transmission	1855790	14446264	717.5						S
MW-S2B-0501	Allison Transmission	1855795	14446265	717.37						D
MW-S3-0501	Allison Transmission	1855827	14446282	717.84						D
MW-S3-0601	Allison Transmission	1855674	14446240	718						D
MW-10-1R	Genuine Parts	1858050	14446241	714.74						S
MW-10-1	Genuine Parts	1858050	14446241	714.74						S
MW-132	Genuine Parts	1857444	14446479	711.54						S
MW-132R	Genuine Parts	1857444	14446479	711.54						S
MW-133	Genuine Parts	1857650	14446290	708.93						S
MW-133R	Genuine Parts	1857650	14446290	708.93						S
MW-135	Genuine Parts	1858028	14446515	713.48						S
MW-145	Genuine Parts	1857575	14446209	707.77	17.5	27.5	28	690.27	680.27	I
MW-146	Genuine Parts	1857898	14446182	708.41	15	25	25.3	693.41	683.41	I
MW-147A	Genuine Parts	1857448	14446491	711.45	20	30	30.5	691.45	681.45	I
MW-147AR	Genuine Parts	1857448	14446491	711.45	20	30	30.5	691.45	681.45	I
MW-148R	Genuine Parts	1857432	14446409	711.21	10.5	25.5	25.5	700.71	685.71	S
MW-148	Genuine Parts	1857432	14446409	711.21	10.5	25.5	25.5	700.71	685.71	S
MW-150	Genuine Parts	1858093	14446374	712.57	4	19	20	708.57	693.57	S
MW-151	Genuine Parts	1858115	14446101	712.6	5	20	20	707.6	692.6	S
MW-152	Genuine Parts	1857911	14446298	712.76	4.8	19.8	19.8	707.96	692.96	S
MW-153	Genuine Parts	1857511	14446282	711.5	4.5	19	20	707	692.5	S
MW-154	Genuine Parts	1857439	14446543	714	5	20	20	709	694	S

MW-155	Genuine Parts	1857345	14446378	717.32	14	29	29	703.32	688.32	S
MW-156	Genuine Parts	1858122	14446218	711.65	5	20	20	706.65	691.65	S
MW-158	Genuine Parts	1857253	14446383	719.94						S
MW-159	Genuine Parts	1858240	14445835	709.84						S
MW-160	Genuine Parts	1857653	14446125	702.18	3.5	13.5	13.5	698.68	688.68	S
MW-161	Genuine Parts	1857511	14446164	703.94	3.5	14.5	14.5	700.44	689.44	S
MW-162	Genuine Parts	1858120	14446484	712.73	10.5	20	20	702.23	692.73	S
MW-163	Genuine Parts	1858122	14446396	712.09	6.5	16.5	16.5	705.59	695.59	S
MW-164	Genuine Parts	1858400	14446165	718.23	21.5	26.5	26.5	696.73	691.73	S
MW-165D	Genuine Parts	1857557	14446045	712.19	42.5	48	48	669.69	664.19	D
MW-165S	Genuine Parts	1857552	14446045	712.31	10.5	20.5	20.5	701.81	691.81	S
MW-166D	Genuine Parts	1857631	14445822	712.49	46	52	52	666.49	660.49	D
MW-166S	Genuine Parts	1857626	14445824	712.7	10.5	20.5	20.5	702.2	692.2	S
MW-167D	Genuine Parts	1857564	14445329	715.61	28	33	33	687.61	682.61	I
MW-167S	Genuine Parts	1857557	14445328	716.07	12.5	22.5	22.5	703.57	693.57	S
MW-168D	Genuine Parts	1858056	14445299	714.46	21	31	31	693.46	683.46	I
MW-168S	Genuine Parts	1858051	14445299	714.58	12.5	22.5	22.5	702.08	692.08	S
MW-169D	Genuine Parts	1857775	14444586	715.69	32	37	37	683.69	678.69	I
MW-169S	Genuine Parts	1857779	14444585	715.92	15.5	26	26	700.42	689.92	S
MW-170D	Genuine Parts	1857344	14445034	717.07	34	39	39	683.07	678.07	I
MW-170S	Genuine Parts	1857343	14445038	717.14	17	27	27	700.14	690.14	S
MW-171D	Genuine Parts	1858137	14444972	711.62	44	49	49	667.62	662.62	D
MW-171S	Genuine Parts	1858137	14444976	711.58	12	22	22	699.58	689.58	S
MW-174S	Genuine Parts	1857337	14445526	717.78	14	24	24	703.78	693.78	S
MW-174D	Genuine Parts	1857337	14445526	717.72	43	48	48	674.72	669.72	D
MW-175S	Genuine Parts	1857336	14445761	718.66	15	25	25	703.66	693.66	S
MW-175D	Genuine Parts	1857336	14445761	718.75	37	42	42	681.75	676.75	I
MW-200	Genuine Parts	1858059	14446335	712.72	45	50	50	667.72	662.72	D
MW-201	Genuine Parts	18581	144460	712.01	36	38	50	676.01	674.01	I

MMW-15S	Apartments	1857444	14445767	713.36	22	32	32	691.36	681.36	I
MMW-15D	Apartments	1857451	14445767	713.08	34	39	39	679.08	674.08	I
MMW-C-02S	Cemetery	1857970	14444756	715.21	18	28	28	697.21	687.21	S
MMW-C-16S	Cemetery	1857755	14444816	717.32	15.9	25.9	25.9	701.42	691.42	S
MMW-P-14S	cemetery	1857365	14444812	714.5	18	28	28	696.5	686.5	S
GP-C-09	cemetery	1857977	14444772	713.9	31	36	36	682.9	677.9	I
MMW-C-02D	cemetery	1857977	14444772	713.9	31	36	36	682.9	677.9	I
MMW-C-16D	cemetery	1857757	14444799	717.27	35	40	40	682.27	677.27	I
MMW-C-17D	Cemetery	1858291	14444173	714.57	33.7	38.7	38.7	680.87	675.87	I
MMW-P-11DR	Cemetery	1857665	14444976	715.63	28	33	33	687.63	682.63	I
MMW-P-14D	Cemetery	1857365	14444790	714.76	29	34	34	685.76	680.76	I
SG-1	SG	1857424	14446140	701.78	0	0	0	685.76	680.76	S
SG-2	SG	1858206	14445154	698.85	0	0	0	685.76	680.76	S
Residential Well										
RES4012COS		1857152	14444226	714.3936		59	62	62	655.39	D
RES4018WVS		1856971	14444698	717.0758		75	80	80	642.08	D
RES4239WCOS		1857486	14445557	717		50	55	55	667	D
RES4020COS		1858128	14444848	717		51	54	54	666	D
RES3908WCOS		1857661	14444094	717		47	50	50	670	D
RES3659WCOS		1858973	14443520	717		41	46	46	676	D
RES3940WCOS		1857894	14443930	717		31	33	33	686	I
RES4042WVS		1856530	14445175	717		34.5	35	35	682.5	D
RES4044WVS		1856988	14443980	717		72	75	75	645	D
RES4017COS		1857152	14444062	717		51	54	54	666	D
RES4140WVS		1856205	14445533	717		32	36	36	685	D

Table 1-2. Groundwater Elevation Data

Monitoring Well	GWE 12-1-11	GWE 7-30-12	GWE 3-1-13	GWE 10-1-10 DRY	GWE 4-28-11 WET
MW-WES-02a	696.01	695.62	697.49		
MW-WES-03a	694.72	694.19	696.3		
MW-WES-04a	697.11	695.9	697.78		
MW-WES-05a	697.52	697.37	699.06		
MMW-10S	697.07	695.64	697.18	695.48	
MMW-11S	697.66	696.19	697.73	696.09	
MMW-12S	697.65	696.05	697.55	696.74	
MMW-1S	697.53	696.12	697.66	695.99	
MMW-2S	697.83		698.02		
MMW-7S	698.52	697.21	698.41	696.98	
MMW-8S	697.68	696.99	697.95	696.21	
MMW-9S	697.1	695.69	697.21	695.46	
MMW-C-01	696.1	694.97	696.87	694.74	
MMW-C-02s	695.48	694.54	696.25	694.36	
MMW-P-01	696.38	695.2	697	695.08	698.35
MMW-P-02	696.03	694.98	696.88	694.81	698.3
GP-02					
MMW-P-03S	696.08	694.96	696.85	694.85	698.27
MMW-P-04	696.31	695.16	697.01	694.84	698.5
MMW-P-05	696.29	695.13	696.96	694.98	698.35
GP-05					
MMW-P-06	696.24	695.13	696.99	695.37	698.38
MMW-P-07	696.91	695.49	697.42	695.31	698.57
MMW-P-08	697.02	695.67	697.39	695.54	698.63
MMW-P-09S	695.02	694.13	695.76	694.01	697.13
MMW-P-10S	697.35	695.54	697.32	695.36	698.79
MMW-P-11S	695.89	694.91	696.85		
MMW-P-12S	697.36	696.29	697.88		
MMW-P-13S	695.77	694.91	696.92		
MW-167S	697.7	696.52	698.15	696.09	699.77
MW-168S	697.29	695.82	697.34	695.37	698.58
MW-169S	695.38	694.5	696.42		697.83
MW-170S	695.86	695.07	697.13	694.7	698.43
MW-171S	696.23	695.99	696.38		697.66
MW-174S	697.31	695.38	697.81		
MW-175S	697.55	696.98	697.85		
MMW-C-02S		694.54	696.25	694.36	697.29
MMW-C-16S		694.62	696.51		
MMW-P-14S		694.54	697.25		
SG-1		701.52	701.02		

SG-2					
MW-WES-01a	695.71	695.1	697.62		
MW-WES-03b	694.73	694.13	696.23		
MW-WES-04b	696.89	695.87	697.94		
MW-WES-05b	697.49	696.35	698.1		
MMW-11D	697.66	696.52	698.05	697.03	
MMW-3S	698.44	696.96	698.11	696.67	
MMW-P-03D	696.13	695.01	696.91	694.83	698.32
MMW-P-10D	696.78	695.42	697.11	695.31	698.42
MMW-P-12D	697.49	696.31	697.95		
MMW-P-13D	695.76	696.46	696.91		
MW-145	699.33				
MW-146	699.21				
MW-147A					
MW-147AR	700.61				
MW-167D	697.66	696.49	698.1		699.38
MW-168D	697.22	695.78	697.26	695.23	698.56
MW-169D	695.34	694.48	696.4		697.86
MW-170D	695.87	695.07	697.13	694.64	698.42
MW-175D	697.75	697.12	698.04		
MW-201	700.39				
MMW-15S		696.47	697.97		
MMW-15D		696.48	698.07		
GP-C-09					
MMW-C-02D		694.56	696.27		
MMW-C-16D		694.6	696.52		
MMW-C-17D		693.42	695.02		
MMW-P-11DR		694.9	696.86		
MMW-P-14D		694.52	696.63		
MMW-P-11D					
MW-WES-01c	695.85	694.79	696.86		
MW-WES-01b	695.61	694.84	696.89		
MW-WES-02b	695.97	695.12	697.16		
MW-WES-02c	696.63	695.16	697.2		
MW-WES-05c	697.45	695.3	697.05		
MMW-13D	697.77	696.46	698.02	696.34	699.33
MMW-14D	697.69	696.54	697.98	696.15	699.25
MMW-4D	698.24	696.82	698.18	696.63	699.55
MMW-5D	698.43	697.07	698.29	696.87	699.65
MMW-6D	698.43	697.11	698.24	696.92	699.74
MMW-P-09D	695.11	694.15	695.81	693.97	697.18
MW-165D	698.64				
MW-166D	698.16	696.78	698.24		

MW-171D	695.71	694.62	696.15	694.23	697.52
MW-174D	696.95	695.45	697.8		
MW-200	699.72				
RES-4012 COS					
RES-4018 WVS					
RES-4042 WVS					
RES-4044WVS					
MW-132R	700.64				
MW-147AR	700.61				
MW-154	700.68				
MW-160	698.88				
MW-161	699.05				
MW-165D	698.64				
MW-165S	698.58				
MW-166D	698.16	696.78	698.24		
MW-166S	698.12	696.75	698.23		
	697.66	696.49	698.1		
	697.7	696.52	698.15		
MW-169D	695.34	694.48	696.4		
MW-169S	695.38	694.5	696.42		
MW-10-1R	699.51				
MW-133R	699.85				
MW-135	700.14				
MW-145	699.33				
MW-146	699.21				
MW-148R	700.49				
MW-150	699.23				
MW-152	699.54				
MW-153	700.04				
MW-302					
IW-1					
IW-2					
MW-151	698.82				
MW-156	699.67				
MW-157					
MW-163	701.34				
MW-164	698.83				
MW-173					
MW-305					
MW-0102-S2	697.05				
MW-0104-S2	702.1				
MW-0105-S2	695.25				
MW-0106-S2A	697.7				

MW-0107-S2	697.09
MW-0116-S2	696.47
MW-0202-S2A	694.91
MW-0202-S2B	697.03
MW-0202-S3	694.8
MW-0210-S3	694.57
MW-0406-S2B	696.98
MW-0409-S2B	695.01
MW-0410-S2	700.29
MW-0412-S2	699.31
MW-0420-S3	694.87
MW-0421-S2A	697.18
MW-0421-S3	694.96
MW-0427-S2B	696.95
MW-0522-S2A	695.71
MW-0522-S2B	695.64
MW-0523-S2	694.65
MW-0524-S2A	696.3
MW-0524-S2B	696.22
MW-0525-S2	697
MW-0526-S2A	696.97
MW-0526-S2B	695.94
MW-0622-S2A	696.49
MW-0623-S2A	695.77
MW-0624-S2	696.56
MW-0625-S2A	695.5
MW-0629-S2	702.28
MW-0629-S3	695.11
MW-0632-S2	697.95
MW-0709-S2	701.51
MW-0803-S2	695.08
MW-0814-S2	694.82
MW-0815-S2	694.74
MW-0816-S2	694.99
MW-0817-S2B	696.71
MW-0817-S3	695.06
MW-0818-S3	695.16
MW-0904-S3	694.99
MW-1001-S2B	697.51
MW-1001-S3	696.45
MW-1002-S2B	697.74
MW-1002-S3	696.97
MW-1002-S3-4	697.13

MW-1003-S3	
MW-16-S2	701.04
MW-28-S2	694.89
MW-30-S2	694.07
MW-31-S2	695.37
MW-32-S2	694.71
MW-33-S2	695.35
MW-34-S2	697.11
MW-3-9-S2	698.26
MW-S2-0601	697.2
MW-S2A-0501	698.82
MW-S2B-0501	697.04
MW-S3-0501	695.07
MW-S3-0601	694.68

Table 1-3 Monitoring Well Water Quality data: Specific conductance

MW	SpC2007	SpC highest 2008 value	SpC2009 (3/2009)	SpC2010 (4/2010)	SpC 2011 Weston data or 5/2011	SpC2012	SpC 2013 (May)	SpC 2013 (9/2013) post injections
MW-WES-02a					1787		1062	1062
MW-WES-03a					1671		1242	1242
MW-WES-04a					887		717	647
MW-WES-05a					1978		778	1105
MMW-10S	1400	5514	3510	1835	1630	1884	2140	1638
MMW-11S	880	3618	2887	960	1108	858	1346	972
MMW-12S			2818	1046	1075	1105	1475	1050
MMW-1S	920	3753	2794	1309	1258	1198	1618	1223
MMW-2S		868		786	619	694	1133	
MMW-7S		3119		1013	1080	632	1273	
MMW-8S	780	3385	2647	891	2259	986	1848	1301
MMW-9S	1500	5173	3678	2012	1878	1864	1978	1340
MMW-C-01		2908	2702	723	463	791	1532	1098
MMW-C-02s		2807	2507	787	689	738	1232	810
MMW-P-01		5619	3419	1493	1978	1698	3293	1877
MMW-P-02		4637	3641	1346	1264	1437	1502	1006
GP-02								
MMW-P-03S		5093	3372	970	1227	971	1109	1315
MMW-P-04		1417		808	1040	769		877
MMW-P-05		6086	2670	1003	1036	734	1819	1177
GP-05								
MMW-P-06		4294	3884	1129	1338	1283	2919	1483
MMW-P-07		6056	4022	1924	1632	1841	2741	1879
MMW-P-08		3646	4083	1804	2362	1709	2765	1092
MMW-P-09S		3920	2249	640	587	709	1155	790
MMW-P-10S		4590	3958	971	1583	673	1989	1200
MMW-P-11S					802	861	1697	968
MMW-P-12S					1106	1173	1990	1469
MMW-P-13S					925	566	583	849
MW-167S				1212	916	1626	3580	
MW-168S		1395						
MW-169S	1045			848	975		1891	
MW-170S		1438		1489	1241	1488	2783	1506
MW-171S		2715			799	792		
MW-174S								
MW-175S					530			

MMW-C-02S		2807	2507	787	812	748	1232	
MMW-C-16S						1141	2374	1020
MMW-P-14S						1242	1886	1102
SG-1								
SG-2								
MW-WES-01a					2195		1058	679
MW-WES-03b					1062		1408	1282
MW-WES-04b					920		867	698
MW-WES-05b					1857		958	859
MMW-11D			2745	946	906	960	1313	974
MMW-3S		2673		933	892	893	1453	
MMW-P-03D		1719	3253	1143	1195	1374	1975	1366
MMW-P-10D		4184	2734	857	598	1225	2242	1560
MMW-P-12D					1070	1323	1882	1489
MMW-P-13D					909	871	989	1003
MW-145	1356	2480	1870					
MW-146	908	1186	1135	1025	1150	1040	929	
MW-147A	1417	3274	2970	1370	2000			
MW-147AR								
MW-167D	791	2800		803	910	855	2013	811
MW-168D		1283	2948	1128	1056	1383	1018	1394
MW-169D	1080	3355		783	880	1062	2524	
MW-170D		970		1149	1040	1587	2191	1350
MW-175D					1306			
MW-201								
MMW-15S						804	1799	1039
MMW-15D						921	1237	604
GP-C-09								
MMW-C-02D						810	686	794
MMW-C-16D						1241	2600	1283
MMW-C-17D						910	2089	883
MMW-P-11DR					802	861	1697	969
MMW-P-14D						1114	2003	1377
MMW-P-11D								
MW-WES-01c					1024		566	604
MW-WES-01b					2787		1139	799
MW-WES-02b					1774		1095	865
MW-WES-02c					1077		1009	752
MW-WES-05c					1996		834	612
MMW-13D			2421	828	878	904	776	883
MMW-14D		5198	2191	751	738	852	1405	873
MMW-4D		1541		1210	1228	1290	1835	1452
MMW-5D		1090		1064	1472	668	1371	

MMW-6D			2907		1061	1239	733	1194	771
MMW-P-09D			8894	2616	885	852	880	1372	879
MW-165D	847		971	959	1307	1600	849	1210	
MW-166D	756		1028	980	980	1210	1370	817	
MW-171D			3179		846	888	891	962	
MW-174D									
MW-200									
RES-4012 COS									
RES-4018 WVS									
RES-4042 WVS									
RES-4044WVS									
MW-132R	892		2550	2750	1074.00	1090			
MW-147AR	1417		2870	2970	1370.00	2000			
MW-154	1890		2350	2470		2890	1260	1390	
MW-160	1436		1321	1043	1747.00	2210			
MW-161	869		1700	958	986	1730	865		
MW-165D	847		971	945	1307	1600	849	1210	
MW-165S	592		988	881	1252	3360	1110	1380	
MW-166D	756		1028	980	980	1210	1370	817	
MW-166S	725		1093	1049	941	1210	1230	1030	
MW-169D	1080		1040	1112	1091	1030			
MW-169S	1045		988	1100	1055	1100			
MW-10-1R	800		849	812	886	910	778	861	
MW-133R	1090		1283	1425	1146	1550			
MW-135	744		744	594					
MW-145	1356			1870					
MW-146	908		1186	1135	1025	1150	1040	929	
MW-148R	1357		1741	1530	1260	1890	1260	1690	
MW-150	904		920	942	921	977	926	931	
MW-152	502		792	795	551	872	591	601	
MW-153	1310		1455	1840	1717	2840	1740	1380	
MW-302	564		697	695	649	688			
IW-1	1139		2630	943	1044	1430			
IW-2	774		855	741	718	805	901		
MW-151	916		959	848	614	982	874	924	
MW-156	818		936	934	716	761	762	852	
MW-157	717		743	776	849				
MW-163	847		920	815	962	905	832	1000	
MW-164	966		925	959	948	1100	1000	992	
MW-173	693		785	698	692	799	773	781	
MW-305			396						

Table 1-4. PCE, VC, and Methane Data

MW	PCE 2013	PCE All	VC 2013	VC All	Methane (oldest available)	Methane (5/2011)	Methane (8/2012)	Methane (9/2013)	Methane (11/2013)
MW-WES-02a	0	0	0	0				0	0
MW-WES-03a	0	0	0	0				0	0
MW-WES-04a	0	0	0	0				0	0
MW-WES-05a	0	0	0	0				0	0
MMW-10S	6.6	37.8	463	278		9700	9800	9890	11000
MMW-11S	0	7.2	0	10.8	18				
MMW-12S	0	0	9.2	114					
MMW-1S	219	400	45.1	39	270	12	15,000	24700	427
MMW-2S	0	0	0	5.2					
MMW-7S	0	0	0	4.5					
MMW-8S	22.5	7.8	163	206		7600	14000	25000	27400
MMW-9S	21.5	5.7	1370	784	4400	12000	17000	7590	7310
MMW-C-01	12.2	15.6	19.6	119		14	14000	16300	16200
MMW-C-02s	0	0	0	0					
MMW-P-01	28.1	18.1	1070	2120		3000	15000	12700	13200
MMW-P-02	11.2	35.6	165	724		17000	15000	4370	11800
GP-02									
MMW-P-03S	0	0	2500	347	59	21000	17000	14200	22700
MMW-P-04	0	0	10.3	68.7		10000	19000	22900	23200
MMW-P-05	0	0	248	53.9	9900	15000	1800	8600	4980
GP-05									
MMW-P-06	0	0	2590	10500	290	17000	15000	18800	25300
MMW-P-07	0	0	239	871		6000	16000	16500	11200
MMW-P-08	0	0	197	245	2800	6800	9200	7340	14300
MMW-P-09S	0	0	0	0	8				
MMW-P-10S	0	192	2.3	419	50	5800	12000	11800	8790
MMW-P-11S	215	471	8.7	12.7		690	5200	297	2100
MMW-P-12S		0	19.4	66.7	24	24	17	73	1180
MMW-P-13S	0	0	0	32.4		4			
MW-167S									
MW-168S	76	0	57.1	34	17				
MW-169S	0	0	0	0					
MW-170S	0	0	0	0					
MW-171S	0	0	0	0					

MW-174S	0	0	0	0					
MW-175S	0	0	0	0					
MMW-C-02S	0	0	0	0					
MMW-C-16S	0	0	0	0					
MMW-P-14S	0	0	0	0					
SG-1	0								
SG-2	0								
MW-WES-01a	0	0	0	0				0	0
MW-WES-03b	0	0	10.7	10.7				29	64
MW-WES-04b	0	0	0	0				0	0
MW-WES-05b	0	0	0	0				5.5	14.6
MMW-11D	0	0	7.7	7.8					
MMW-3S	0	0	0	4.4					
MMW-P-03D	0	0	664	179	1200	14000	21000	1130	28800
MMW-P-10D	0	0	2020	1780		18000	20000	29800	26700
MMW-P-12D	0	0	37.8	96.1		26	20	15	117
MMW-P-13D	0	0	120	170		20			
MW-145		0		6.1					
MW-146		0		0					
MW-147A		0		0					
MW-147AR		0		0					
MW-167D			9.6	19.6					
MW-168D	0	0	100	122	16000				
MW-169D	0	0	27.2	22.6					
MW-170D	0	0	48	63.6					
MW-175D	0	0	0	0					
MW-201	0								
MMW-15S	0	0	0	0					
MMW-15D	0	0	2.7	2.7					
GP-C-09	0								
MMW-C-02D	0	0	275	162					
MMW-C-16D	0	0	165	349					
MMW-C-17D	0	0	5.6	2.1					
MMW-P-11DR	0	0	101	102			590	290	1020
MMW-P-14D	0	0	94.4	58.3					
MMW-P-11D									
MW-WES-01c	6	7.4	18.1	18.1				20	551

MW-WES-01b	0	0	20.2	65.2				0	31.2
MW-WES-02b	0	0	6.7	17.9				0	0
MW-WES-02c	0	0	3.3	2.1				310	409
MW-WES-05c	0	0	0	0				0	0
MMW-13D	0	0	139	182					
MMW-14D	0	0	150	140					
MMW-4D	0	0	124	206					
MMW-5D	0	0	168	94.1					
MMW-6D	0	0	49.4	75.2					
MMW-P-09D	0	0	67.5	85.7					
MW-165D			166	167					
MW-166D			250	469					
MW-171D	0		4.7	9.5					
MW-174D	0	0	0	0					
MW-200									
RES-4012 COS	0	0	26.1	26.1					
RES-4018 WVS	0	0	4.8	4.8					
RES-4042 WVS	0	0	0	0					
RES-4044WVS	0	3	4.7	4.7					
MW-132R		0	0	0					
MW-147AR		0		0					
MW-154				0					
MW-160		0		17					
MW-161		0		0					
MW-165D				167					
MW-165S									
MW-166D				469					
MW-166S									
MW-169D		0		27.1					
MW-169S									
MW-10-1R				4.2					
MW-133R				0					
MW-135		0		0					
MW-145		0		6.1					
MW-146		0		0					

MW-148R		0		120					
MW-150		0		0					
MW-152		0		0					
MW-153		0		0					
MW-302									
IW-1									
IW-2									
MW-151		0		0					
MW-156		0		0					
MW-157		0		0					
MW-163		0		52					
MW-164		0		0					
MW-173		0		0					
MW-169D		0		0					

Evaluation of Localized Groundwater flow in a Contaminated Surficial Aquifer in Speedway, Indiana, 2014

By Amy M. Gahala

Prepared through Interagency Agreement with the U.S. Environmental Protection Agency

Disclaimer: This report and the statements within have not been reviewed by the U.S. Geological Survey. The author is writing this report under the authority of the IAG for the U.S. Environmental Protection Agency.

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Evaluation of Localized Groundwater flow in a Contaminated Surficial Aquifer in Speedway, Indiana, 2014

By Amy M. Gahala

Abstract

The localized groundwater flow has been evaluated to determine the potential for contaminants to migrate from a source site towards a southwest residential area. Existing water level data and water quality parameter data were reviewed and used to create water-level contour maps and iso-concentration maps. Vertical gradients were calculated for nested well sites and contoured to show locations of upwards and downwards flow. Iso-concentration maps were created for specific conductance, PCE, VC, and methane to delineate plume location and potential plume migration. This information is provided to EPA officials for assessing the source of the residential area impacts.

Water-level contour maps were created for two observed extreme (wet and dry) groundwater elevation periods and one recent period. The Dry period induced radial flow from Source Area B. The Wet period shifted this radial flow westward. The recent groundwater elevation data suggests radial flow at the Source Area B and radial flow west of the contaminant source. The deep aquifer has a westward flow component in the northeastern half of the site and south-southeastern flow towards the southern half of the site.

Vertical gradients indicate a combination of upwards and downward vertical flow within the aquifer. On average there is a slight upwards groundwater flow at the source areas and a strong downwards vertical gradient near the residential area. This upwards vertical gradient at the source area is consistent during dry period, but during the wet period, the vertical gradient reversed slightly downward and the southern half of the site became an upward gradient.

Plume locations were identified with specific conductance data and consistent with previous plume delineation reports (Beodray, 2013). Comparison of specific conductance for seven separate time periods indicate a possible westward flow component within the aquifer but an overall southeast flow direction. Specific conductance was also comparable to the PCE, VC and methane iso-concentration maps and they also indicate a possible westward flow component.

The groundwater elevation data, specific conductance and water quality data allude to the presence of a preferential flow path from the source areas to the residential area. Heterogeneous geologic conditions within the aquifer produce localized radial flow and upwards vertical flow from the Source Area B and the groundwater then flows through the higher conductive sands and gravels. The flow resumes its southeastern flow direction south of the source areas.

Acknowledgements

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Introduction

An analysis of existing data has been completed to help determine potential contaminant transport pathways at West Vermont Street, Speedway, Indiana. The West Vermont Drinking Water Contamination Site is located within a residential area in Speedway, Indiana in which 25 homes rely on private drinking water wells as their only source of water (Figure 1). Three homes in this residential area have had vinyl chloride and or perchloroehtylene (PCE) detected in their wells. Releases of PCE and its degradation products originate from nearby source areas located beneath Michigan Meadows Apartments and Michigan Plaza (figure 2). There is an additional source of trichloroethylene (TCE) and related degradation products originating from Genuine Parts. PCE was detected very sporadically at low levels, 10-15 years ago at the Genuine Parts site. PCE may or may not be migrating from the Genuine Parts site. The direction of groundwater flow in the area is not completely understood and the PRP (Potentially Responsible Parties) for the Michigan Plaza Site has asserted that groundwater from their site does not flow toward the residential area; therefore, they are not responsible for the contamination of drinking water wells. The regional groundwater flow direction is believed to be generally south and southwest, based on a series of potentiometric surface maps (Grove 1,2). The local groundwater flow direction has been determined in this analysis using groundwater elevation and water quality data.

Figure 1. Regional view of the West Vermont Street Contamination Drinking Water Area Site and residential area

A review of available groundwater elevations (GWE) and water quality samples that have been collected from 2005 to present by environmental consulting firms representing the PRP and the USEPA (2005-present by Mundell and Associates, Inc.; and 2010-present by Weston Solutions, Inc.) has identified a period of high groundwater elevations (wet) and a period of low groundwater elevations (dry). The "wet" and "dry" GWE data have been used to create water-level contour maps on a local scale to assess transient changes in groundwater flow direction. A water-level contour map was also created for a more recent set of GWE data to represent "normal" conditions (3-1-2013). The "normal" is representative of typical or average conditions because the GWE fell between the two extremes (wet and dry). Vertical gradients have been calculated and presented in a contour map depicting areas of upward and downward vertical migration for dry, wet, and averaged data. Elevated specific conductivity (SpC) concentrations were observed at locations with contamination, therefore, iso-concentration contour maps have been created for SpC to identify areas of higher conductivity to represent potentially contaminated areas. Changes or shifts of the SpC plume were used to show localized groundwater flow direction (Degnan and Brayton, 2008). The SpC maps are also compared to PCE, VC and methane iso-concentration maps to verify locations of plume delineation and migration pathways.

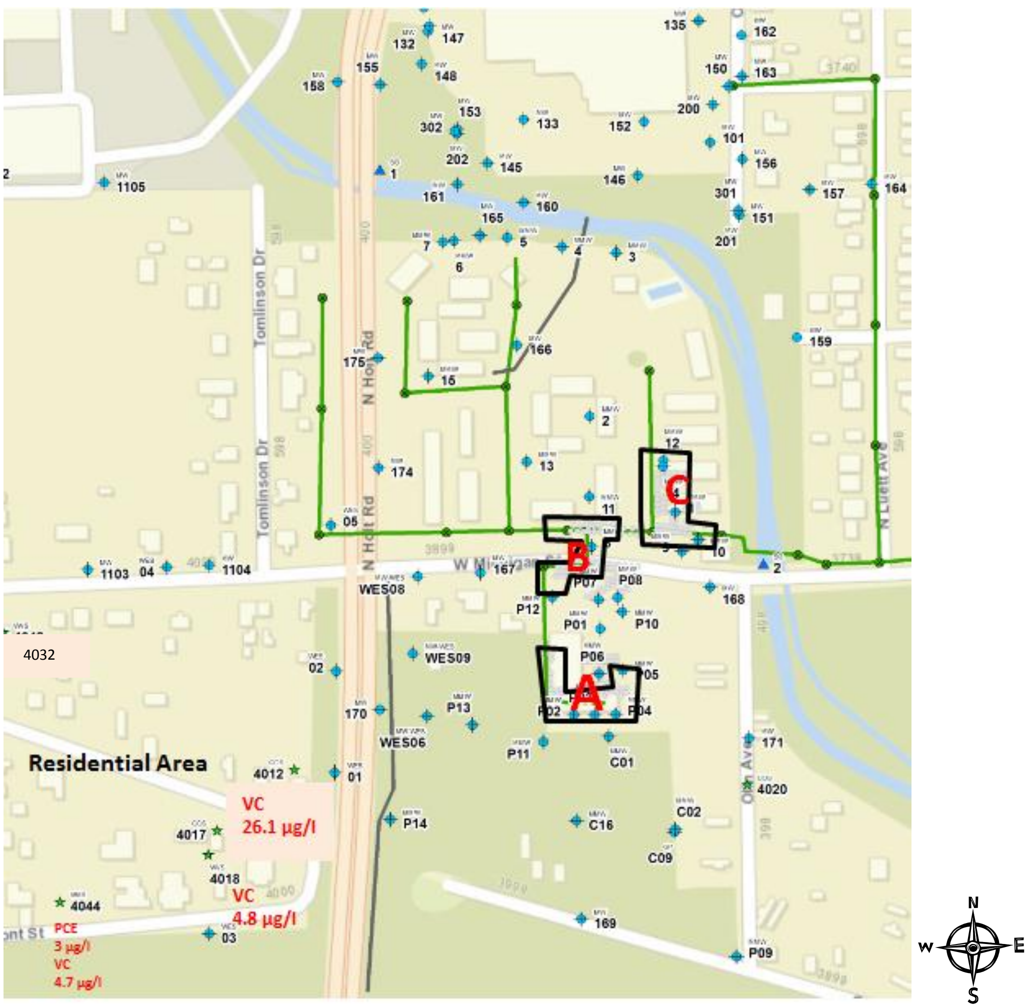


Figure 2. Locations of Source Areas within the site and the residential area.

Purpose and Scope

The purpose of this report is to present potential local groundwater flow directions based on available data at the West Vermont Drinking Water Contamination Site in Speedway, Indiana. The data was not collected with the intention of determining groundwater flow paths, but rather to define the existing contaminant plume and assess remediation efforts. Data gaps exists where sampling was omitted or where monitoring wells were only recently installed. Therefore, this limits the ability to make any interpretations without further investigation. The scope of work uses a compilation of existing water level data, SpC and contaminant concentration data to define the plume and observe the transient changes in the groundwater elevation and plume delineation. The water level data was used to create water-level contour maps for dry, wet and normal periods observed in the records. The water levels were also used to evaluate the vertical hydraulic gradients within nested wells for dry and wet periods and the cumulative data was averaged and contoured to depict typical vertical gradients. The specific conductance data taken during sampling was used to determine contaminated areas and potential flow paths. The specific conductance data is compared to PCE, VC and methane iso-concentration maps to further delineate the plume and migration pathways. This report presents information needed by EPA officials to determine the best course of action for preventing further residential area contamination.

Description of Study Area

The West Vermont Drinking Water Contamination Site is located in the city of Speedway, Indiana and is bounded to the north by West 10th Street, Grand Avenue to the west, the City of Speedway WWTP to the south, and Little Eagle Creek to the east. The site covers an area of approximately 0.118 square miles (0.306 km^2). Land-surface altitude ranges from about 698 to 720 feet (ft). Land cover in the area consists of mixed residential and commercial.

Approach and Method

Existing water elevation data from previously installed wells are used to develop water-level contour maps and vertical hydraulic gradient maps from 2005 to present. Water level measurements were made with electric tape by Mundell and Associates, Inc., and Weston Solutions, Inc., on behalf of the PRPs and the US EPA. Monitoring wells have been previously surveyed by a licensed surveyor subcontracted by Mundell and Associates, Inc. and by Weston Solutions, Inc. Groundwater flow directions need to be understood at local, intermediate and regional scales in order to assess the potential for contaminant transport. The local scale groundwater flow directions within the alluvial aquifer were assessed by dividing the monitoring wells into shallow, intermediate and deep aquifer zones. The shallow zone is defined as wells screened at or above 686 ft amsl. These wells are typically water table wells. The intermediate zone is in the middle of the aquifer at 670-685 ft amsl and the deep zone wells are screened at 670 ft amsl or less. The deep monitoring wells are closest to the clay layer where present. Also, because this is all the same aquifer, all the water level data was combined for the shallow, intermediate, and deep zones to determine the intermediate scale groundwater flow directions. Potentiometric surface maps were created for synoptic data available on 7-30-2012 and 3-1-2013. These dates provided a larger data set which included the newer wells installed near the residential area. A regional scale groundwater elevation contour map was also created to determine the general flow direction for the entire region depicted in Figure 1 (GWE data from 12-1-2011). Well details and data can be found in the Appendix of this report.

A review of water level data collected indicated a period of low GWE (10/11/2010) and a period with high GWE (4/28/2011). Potentiometric surface maps were created for the two extremes, denoted as "Wet" and "Dry," for all three aquifer zones to evaluate the transient groundwater flow directions. A potentiometric surface map created from the most recent synoptically available GWE (3/1/2013), denoted as "Normal" is compared to the extremes. The term "normal" is being used to describe groundwater elevation data that falls between the range of the two extremes (dry vs. wet).

Vertical hydraulic gradients for clustered well sites were calculated to determine the vertical direction (upward or downward) of groundwater flow within the aquifer. Groundwater elevation data from the shallow monitoring wells were subtracted from the deep monitoring wells (shallow minus deep) and the difference is divided by the distance between the two open boreholes for the wells (in feet). Shallow monitoring well GWE that is lower than the deep has a difference that is negative (upward flow). Deep monitoring well GWE that is lower than the shallow GWE has a difference that is positive (downward flow). The negative and positive differences are contoured to display locations of upward and downward flow for the wet and dry GWE data sets. The vertical gradients were also observed through time and the average is mapped to determine the consistency of the vertical movement of the groundwater. Values greater than 0.05 and -0.05 were considered significant for vertical flow direction evaluation.

The field sampling parameter, specific conductance, is also used to delineate plume extent and potential flow paths. Specific conductance is a measure of dissolved ions within the water and is routinely measured during field sampling and used as a general water quality indicator (ITRC, 2008). Specific conductivity has been widely used as a tracer for surface water and groundwater flow paths (Cox and others, 2007; Winter and others, 1998; Marin and others, 1998; Smith and others, 1991). Instruments used for field parameters measured were calibrated daily before use. Iso-concentration maps were created for specific conductance from 2007 through 2013 with all aquifer zones (S, I and D) combined. For some years, the aquifer was divided into zones to further clarify plume source and flowpaths.

This site has received periodic edible oil treatment in 2007, 2009, and 2013. The edible oil boosts the microbial degradation process and accelerates reductive dechlorination (Henry, 2010). Chloride is a general water quality parameters that is produced by anaerobic dechlorination of chlorinated solvents released in the groundwater. Elevated levels of chloride indicate that dechlorination is occurring. According to the ITRC (2008), chloride levels that are found to be three times background can be used to identify plume locations. Chloride has not been measured at this site, however, specific conductance has been shown to have a strong correlation to chloride ions in groundwater (USGS, 1995; Christensen, V.G and others, 1999; Kunze and Stroka, 2004). The data provided has indicated an imperfect (r^2= 0.10) correlation between contaminants and SpC. However, there was a general observation of higher SpC at wells near the source area. The poor correlation may be due to interference from the edible oil treatments and general data variability. Specific conductance is being used as a general proxy for chloride in this analysis. If specific conductance is 2 to 3 times background (in lieu of using chlorides), it is used to indicate possible contaminant location and plume migration. The lowest detected specific conductance data have been around 500-700 uS/cm. Therefore, an SpC greater than ~1200 µS/cm was assumed to be influenced by contamination.

The specific conductance iso-concentration maps are compared to PCE, VC and methane iso-concentration maps to verify that it is appropriate to use elevated specific conductance as a potential indicator for plume delineation and to help assess potential groundwater flow paths.

Hydrogeologic Setting

The West Vermont Contamination site is situated on unconsolidated glacial deposits and glacial outwash material consisting of sands, silts and clays. According to the IDNR, Division of Water (2011), the principal freshwater-bearing aquifers underlying the site include the surficial New Castle/Tipton Complex Aquifer System and the White River and Tributaries Outwash Aquifer System. The New Castle/Tipton Complex Aquifer System consists of thick sequences of clays with interbedded sands and gravels that are highly variable in thickness, depth and lateral extent. This aquifer is mapped northeast of the site. This aquifer is considered prolific and adequate for domestic and high-capacity users. The White River and Tributaries Outwash Aquifer System is the primary shallow aquifer for the site and it consists of glacial outwash overlain by an intermittent and irregularly thick layer of clay and silt deposits.

A review of the borehole well logs for this site confirms the presence of intermittent and irregularly thick layer of clays and silt deposits. The clay layer thins dramatically towards the east and northeast and is altogether missing towards the north. It is thickest (25-30 ft) towards the south and southwest. The clay is described as non-plastic, stiff, and moist to dry.

Direction of Groundwater Flow

Groundwater flow directions were determined at the three scales for groundwater flow: local, intermediate, and regional. Contaminant transport is primarily controlled by local and intermediate flow directions (Focazio and others, 2002).

Approximately 70 monitoring wells were used to determine the local groundwater flow direction in the shallow, intermediate and deep aquifer zones (figure 3). The zones are divided in the shallow zone (>686 ft amsl) which is at or near the water table; the intermediate zone (670-685 ft amsl) (middle of aquifer); and the deep zone (<670 ft amsl), which is closest to the clay layer (if present). All the wells are within the same aquifer. Potentiometric surface maps were developed for the shallow, intermediate, and deep portions of the aquifer for the wet, dry and normal periods in order to determine the localized transient flow patterns. The intermediate groundwater flow directions were obtained by creating a potentiometric surface map for all the aquifer wells within the area as shown on figure 2. The regional groundwater flow directions were obtained by creating a potentiometric surface map for all the aquifer wells within the area shown on figure 1 (approximately 180 monitoring wells).

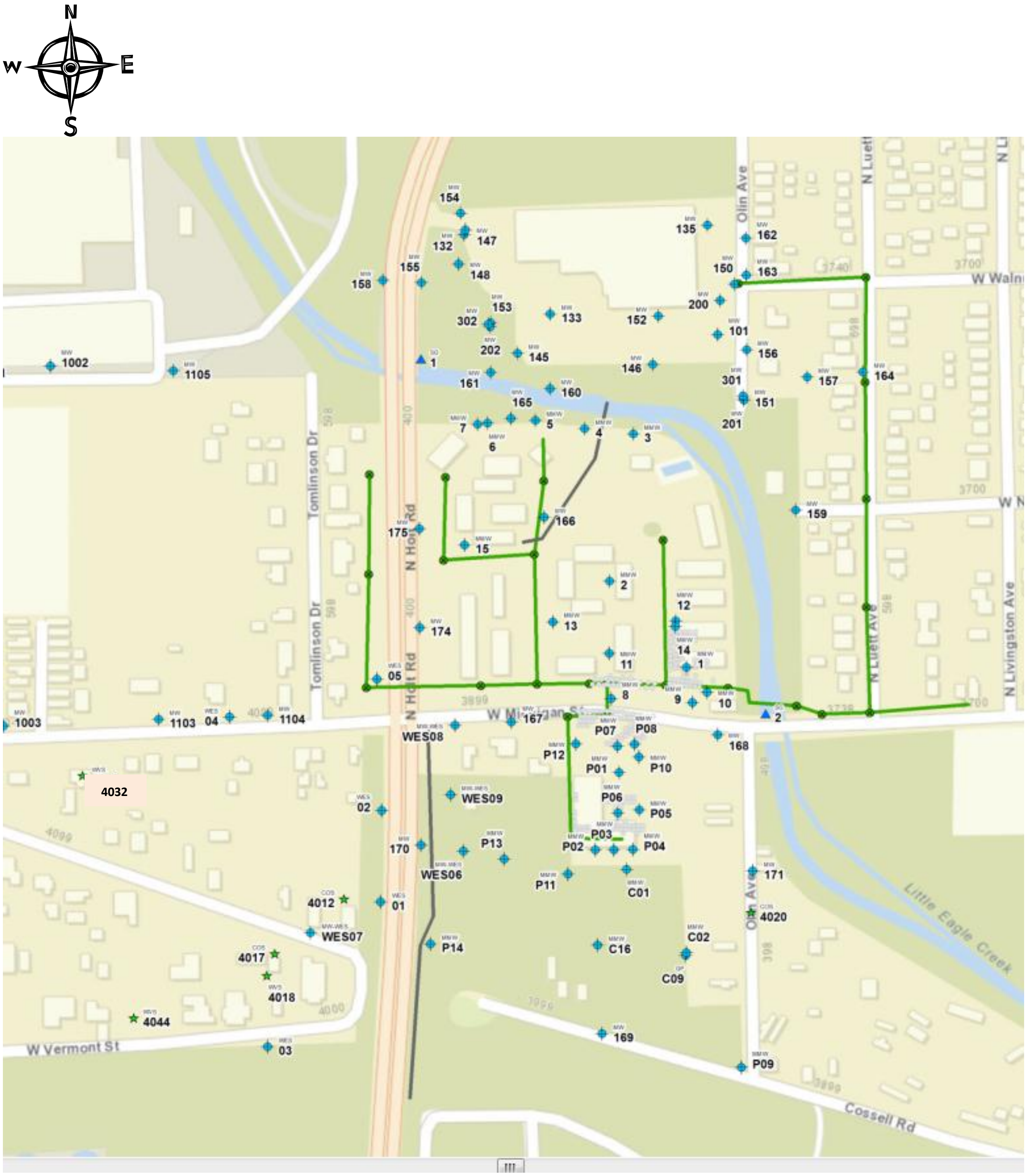


Figure 3. Monitoring Well Locations

Local Scale

Groundwater in the shallow aquifer zone generally flows from areas of high hydraulic head (interstream divides) to areas of low hydraulic head at surface-water discharge areas (i.e. Little Eagle Creek and Eagle Creek). The direction of flow is perpendicular to the water-table contours. The highest hydraulic head occurs north and northwest of Michigan Street at the Michigan Meadows Apartments . The lowest hydraulic head occurs at MMW-8S and at discharge zones east and south towards Little Eagle Creek (Figure 4). Periods of low groundwater elevations within the shallow aquifer show a predominately southern flow with some localized areas of higher hydraulic head at MMW-11S, MMW-P-11S and MMW-8S (figure 5). Periods of high groundwater elevation (wet) within the shallow aquifer increase the occurrence of some radial flow at MW-167S, MMW-P-10S, MMW-P-01 and MMW-C-01 (figure 6).

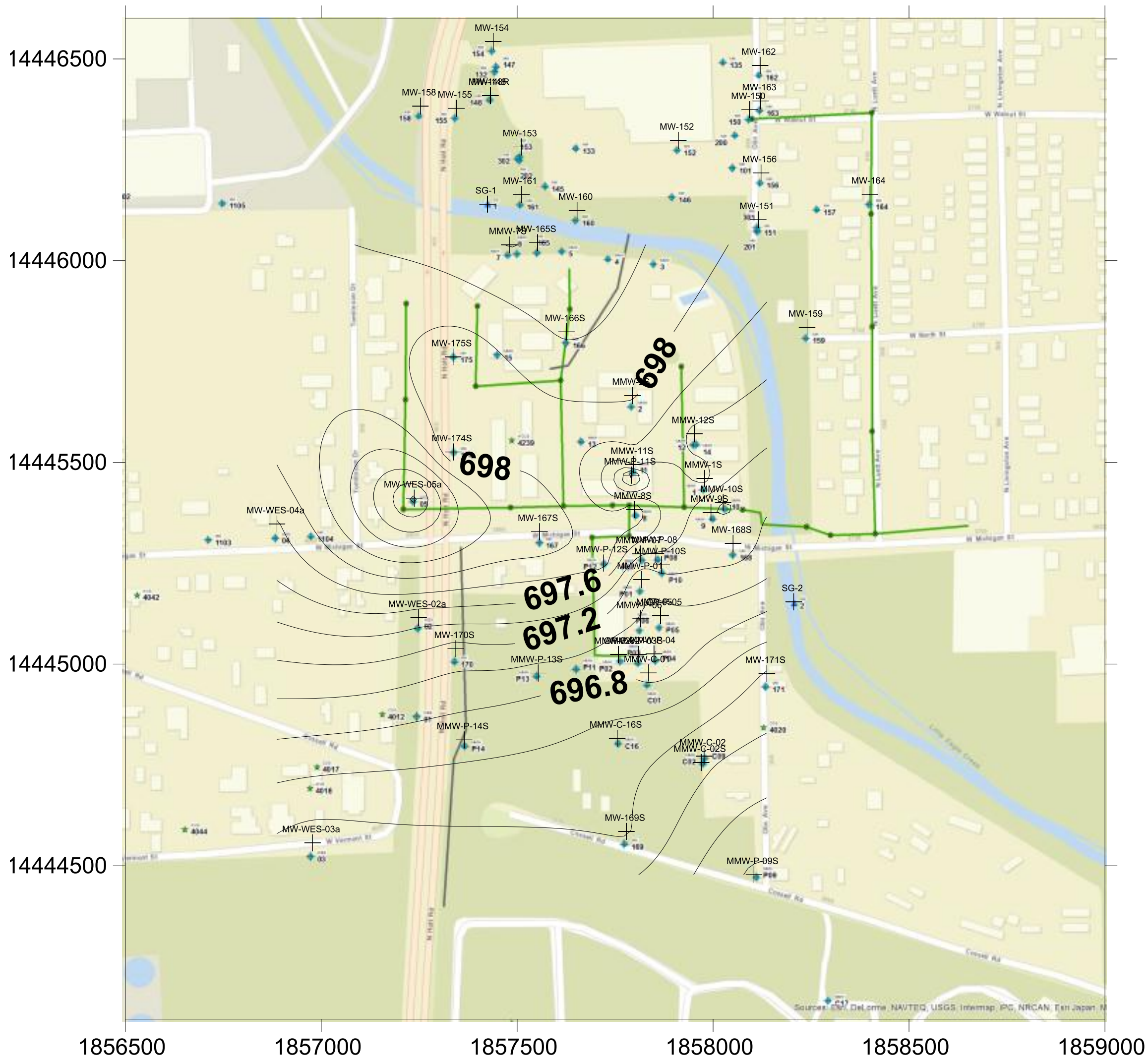


Figure 4. Shallow aquifer zone water-table contours for the normal GWE data.

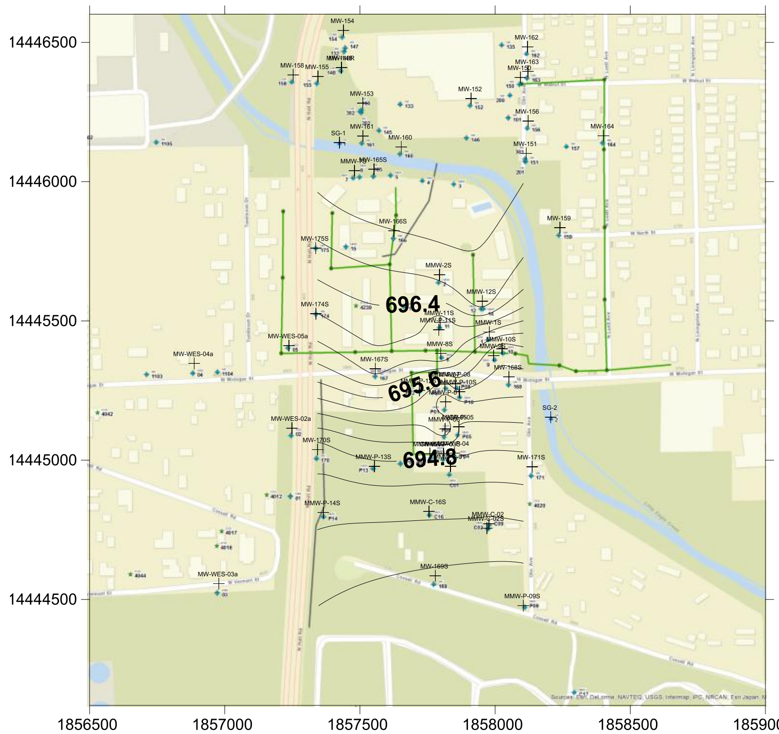


Figure 5. Shallow aquifer water contours for the dry period GWE data.

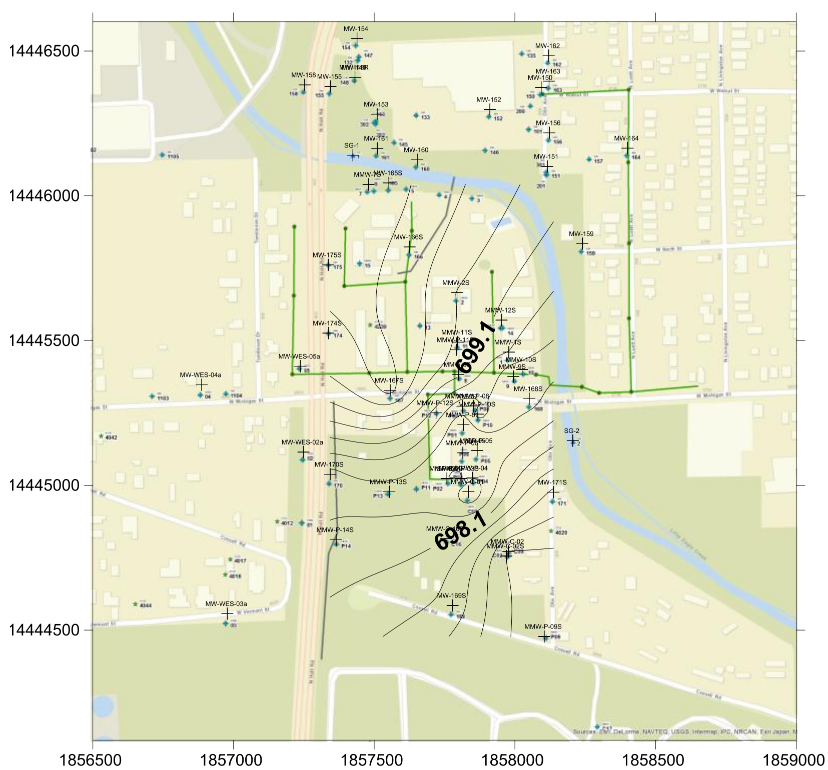


Figure 6. Shallow aquifer water table contours for wet GWE data.

The intermediate portion of the aquifer has a primarily south-southeast flow (figure 7). The period of low groundwater elevation (dry) indicate pronounced radial flow from monitoring wells within the Michigan Meadows Apartments location (figure 8). The flow direction shifts exclusively southeast during the wet period (figure 9).

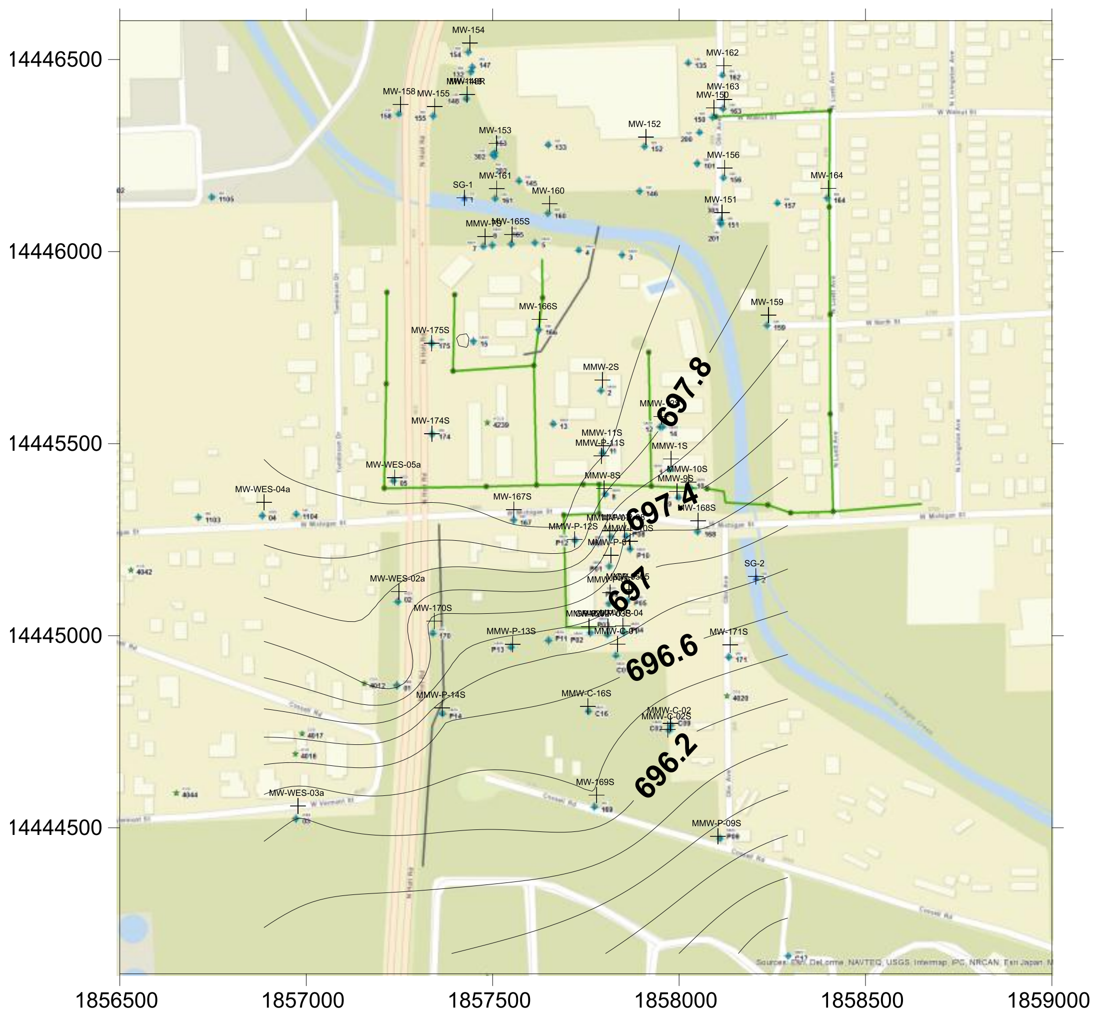


Figure 7. Intermediate zone water table contour map for recent GWE data.

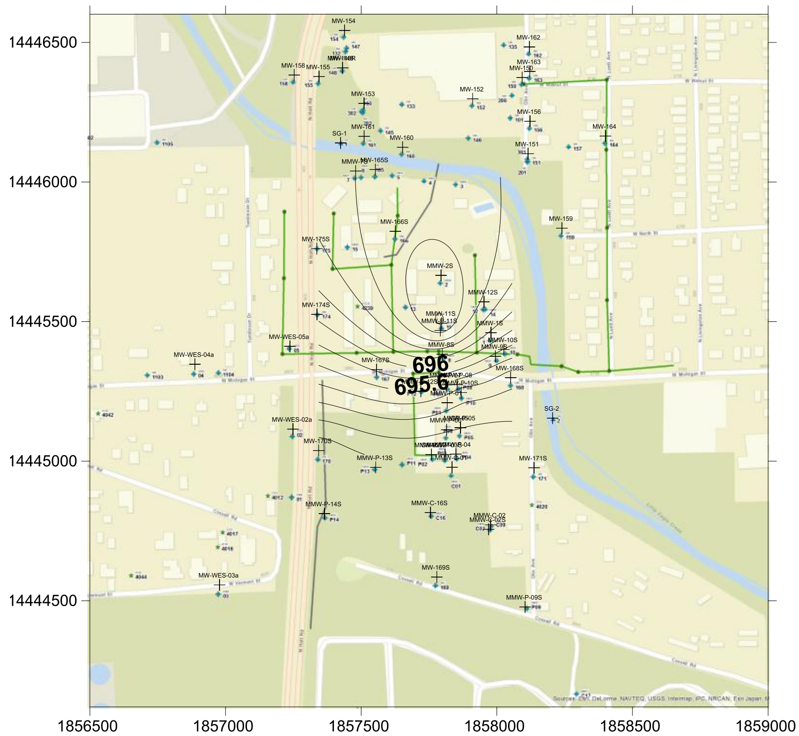


Figure 8. Intermediate aquifer water table contours for dry GWE.

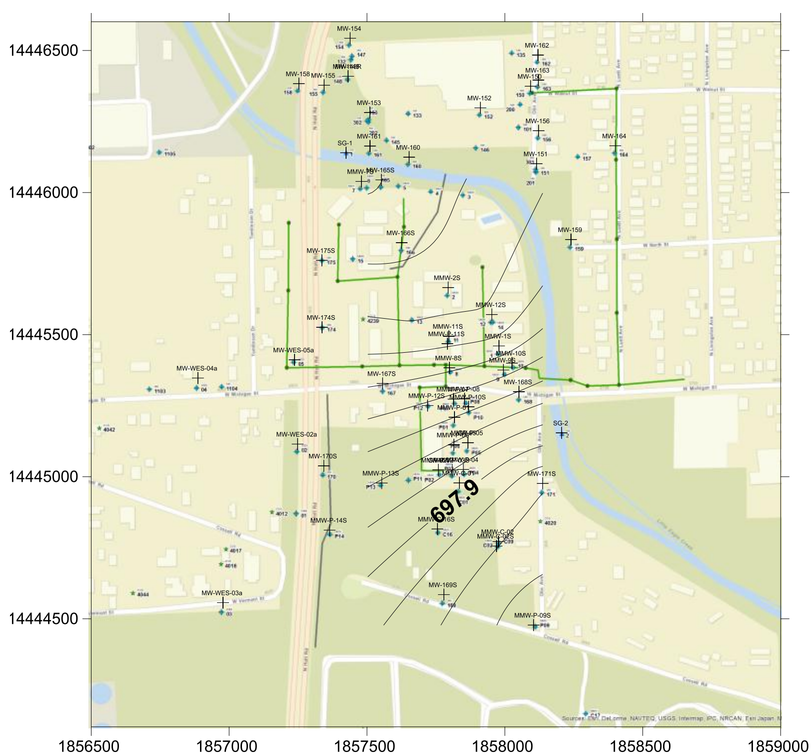


Figure 9. Intermediate aquifer water table contours for wet GWE.

The deeper portion of the aquifer exhibits radial flow at the Michigan Meadows Apartment property with a westward flow component towards the residential area, however, the flow resumes a south-southeastern direction after Michigan Plaza (figure 10). Only a few data points were available for the dry and wet periods in the deep wells. These points are predominately located at Source Area A and southeast. The data indicates a southeastern flow direction. The wet period data was also limited to the Michigan Plaza area and it depicted a southeasterly flow direction (figure 11 and 12).

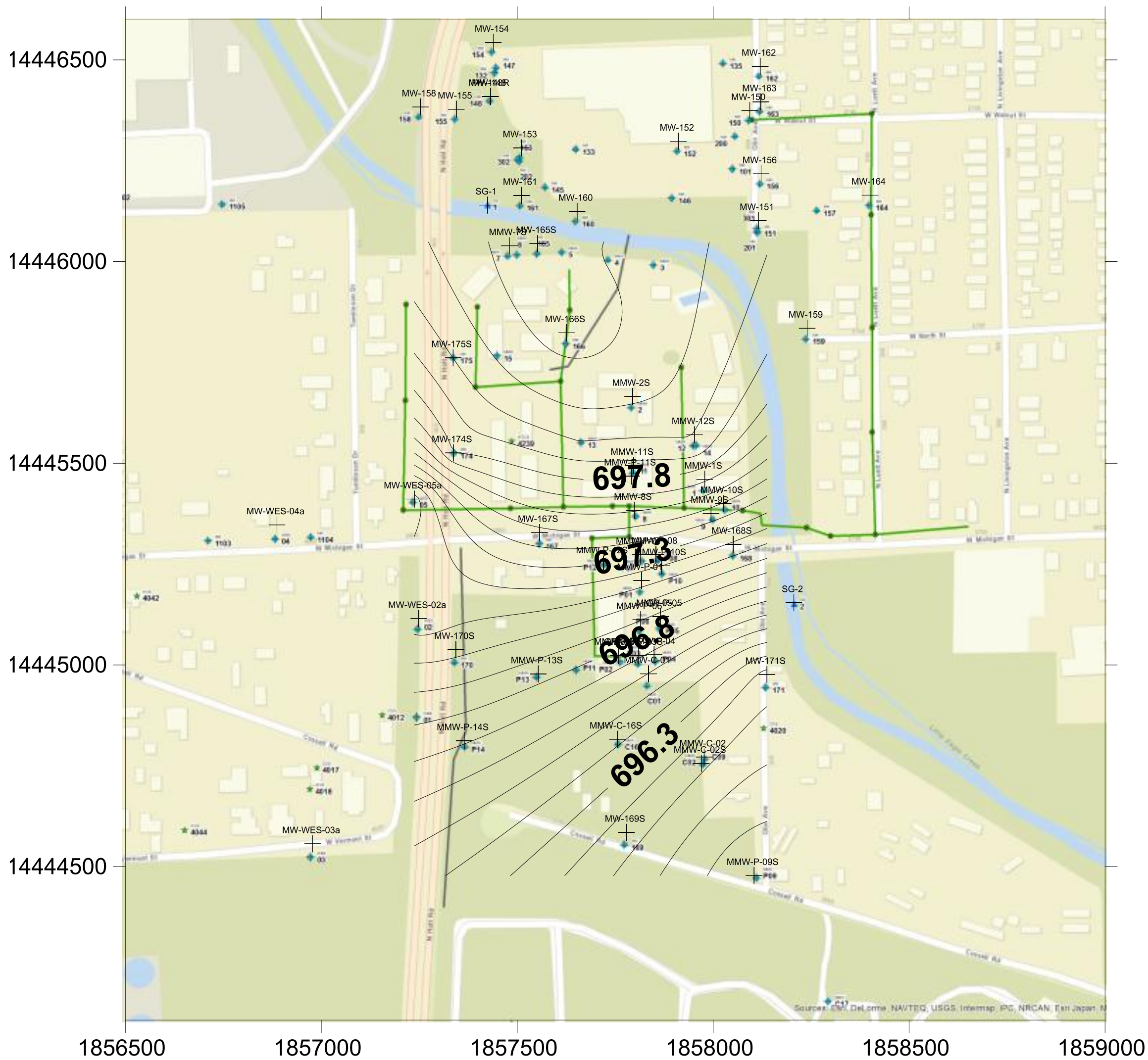
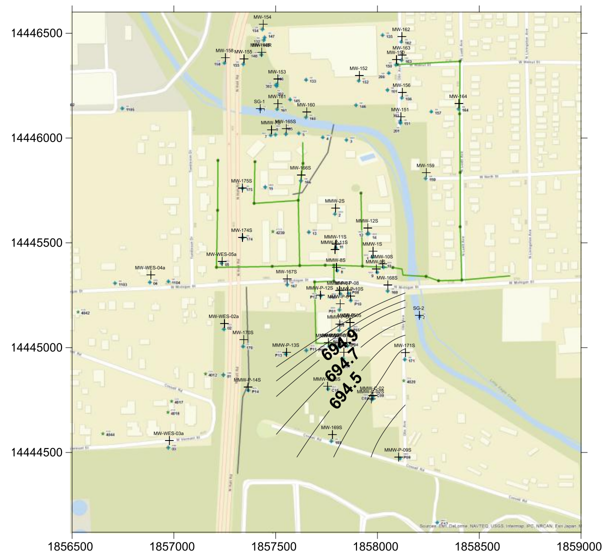
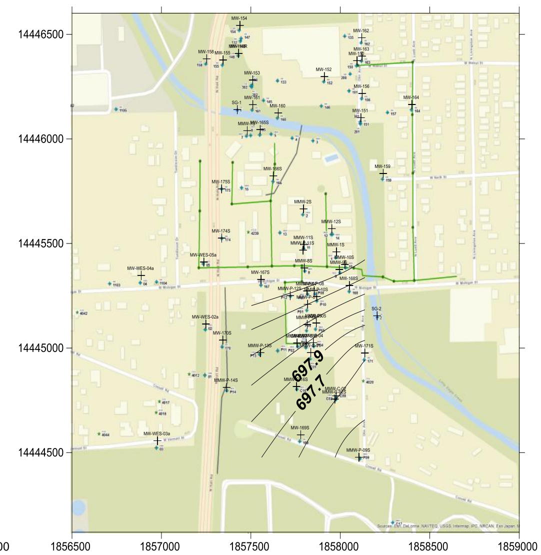


Figure 10. Deep aquifer water-table contours for recent GWE data.





Figures 11 and 12. Deep aquifer “dry” water table contours (left) and “wet” water table contours (right).

The contoured dry, wet and normal data GWE data reveals the transient nature of flow paths for the aquifer. Potentiometric surface at the Michigan Meadows Apartments expresses some radial flow that also moves westward during high GWE periods. This transition of groundwater flow could potentially divert some contaminants from the Source Areas westwards.

Intermediate Scale

The Intermediate Scale potentiometric surface maps were created for all the wells within the aquifer. The Intermediate Scale Flow directions are assessed by combining the shallow, intermediate, and deep monitoring well data and contouring the groundwater elevations. Synoptic GWE data from 7-30-2012 (figure 13) shows sinuous and radial flow north of Michigan Street with a westward flow component along Holt Rd. Flow direction is typically southeast and south with a few areas of radial flow and some westerly flow. There is a groundwater divide running east-west from MMW-1S to WES-02.   Synoptic GWE data for 3-01-2013 (figure 14) also shows similar radial flow pattern along the 697.0 contour slightly north and along Michigan St with a slight westerly flow component along Holt Rd at the 697.5 contour near WES-09 and WES-08.

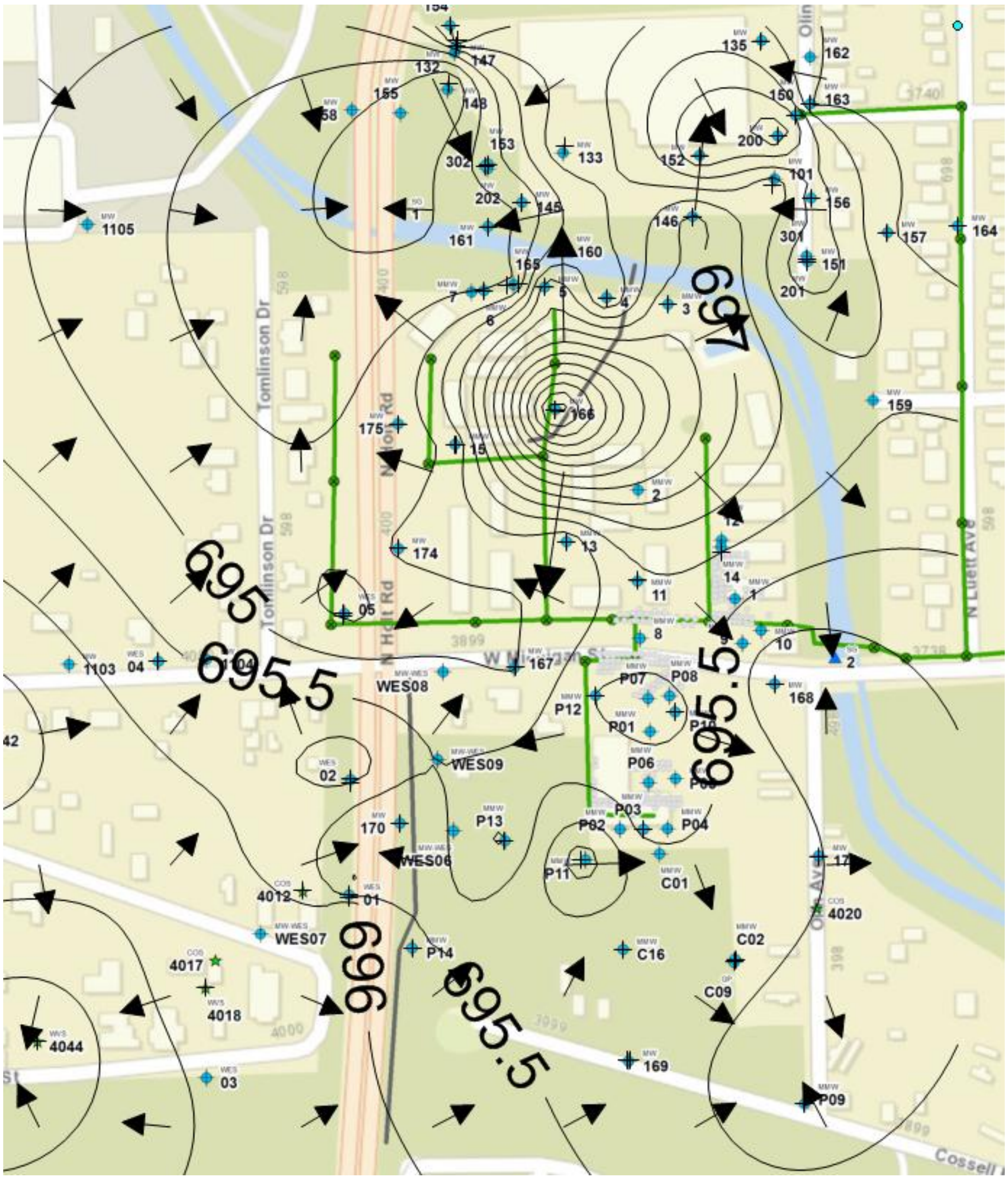


Figure 13. Intermediate Scale GWE elevation contour map for 7-30-2012 data.

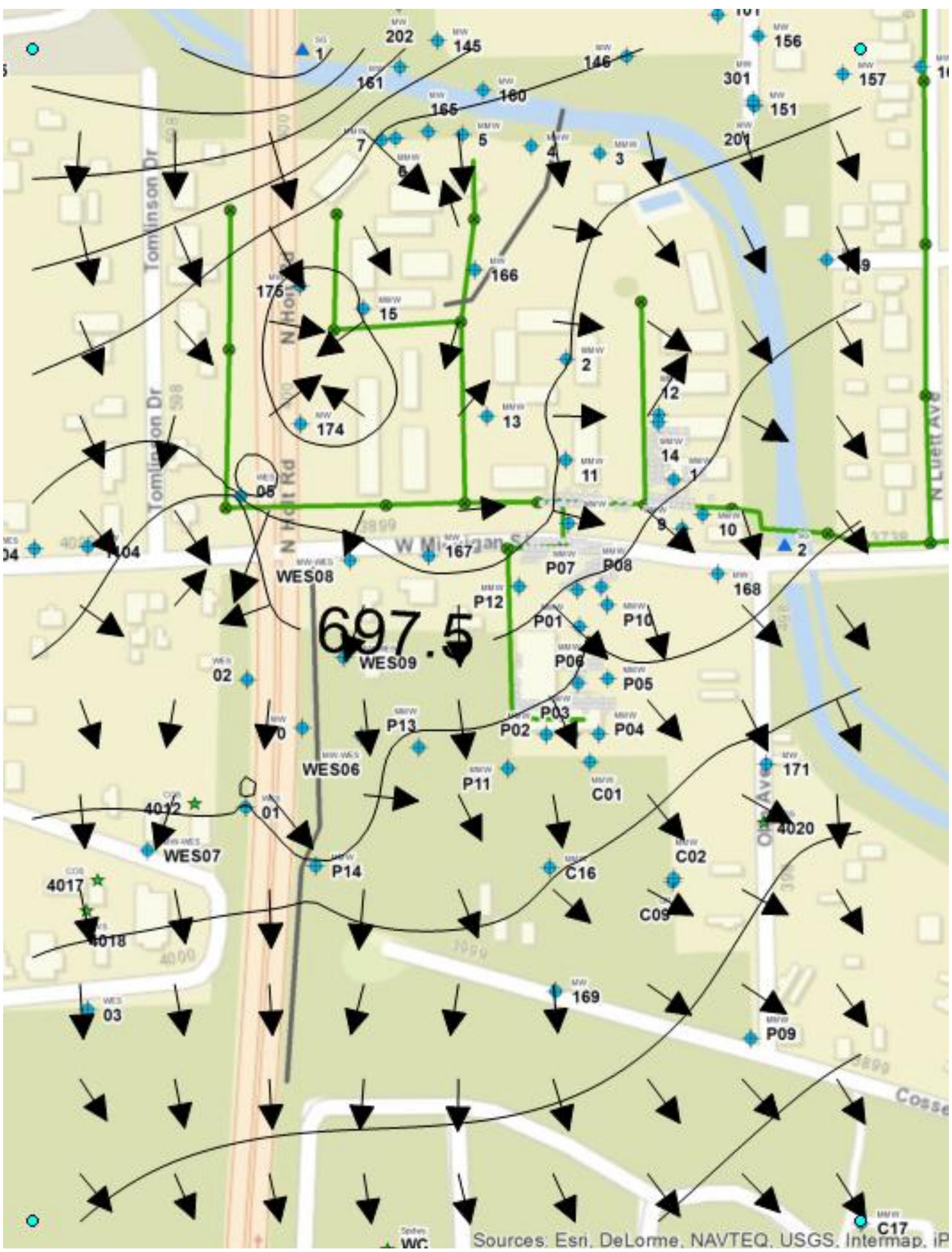


Figure 14. Intermediate Scale GWE contour for 3-01-2013 data.

Regional Scale

The Regional Scale potentiometric surface map (figure 15) was created using available monitoring well data for the region depicted on figure 1. This includes all the monitoring wells available for the region in the same aquifer. Monitoring well GWE data is from Allied Transmission, Genuine Parts, and Michigan Meadows Apartments/Plaza. The regional groundwater flow direction is predominately south and slightly southwest closer towards Eagle Creek. There is some radial flow with a southwesterly component just south of Little Eagle Creek and at the Michigan Apartments.

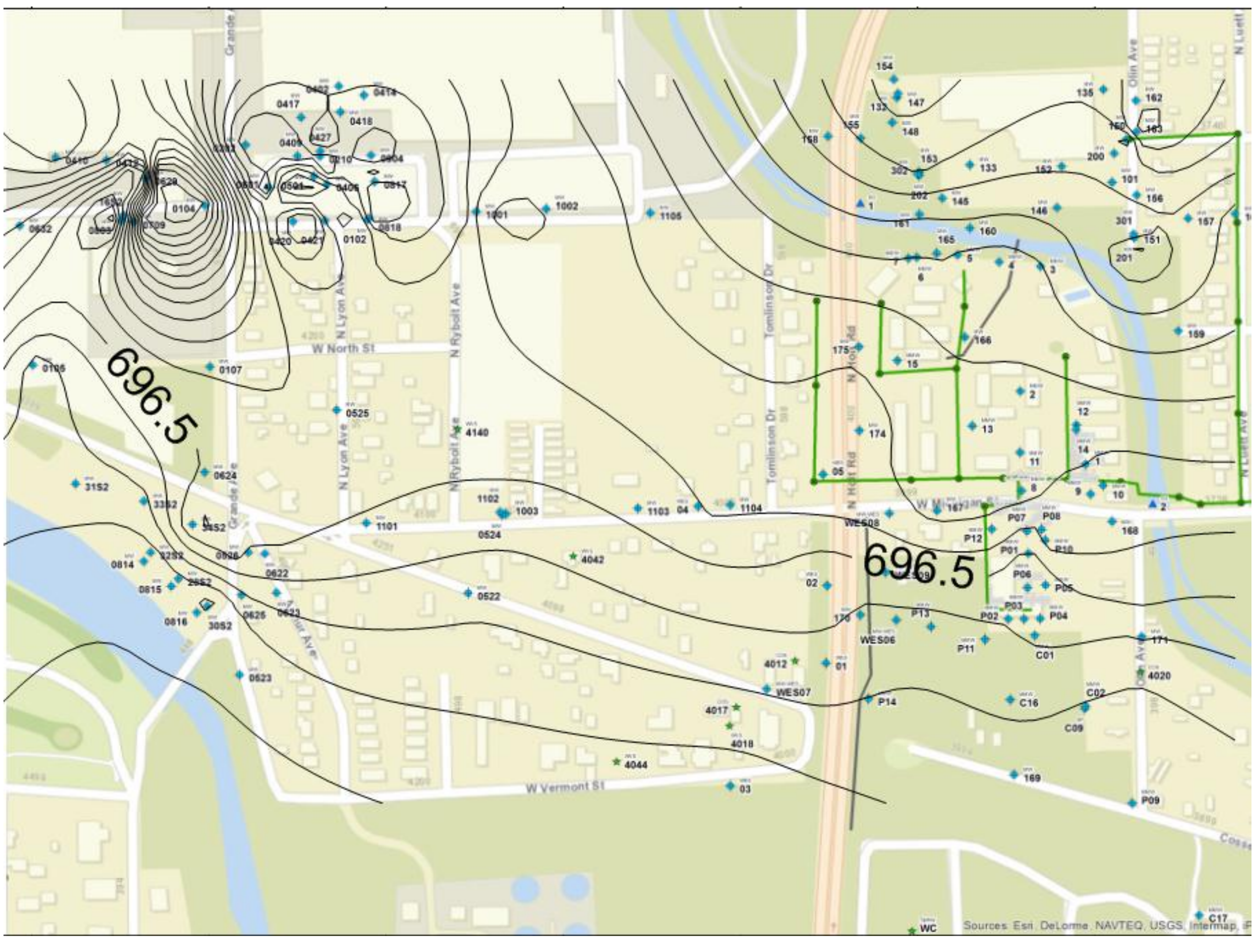


Figure15. Regional Scale Groundwater Potentiometric Surface map

Vertical Hydraulic Gradients

The effectiveness of a clay unit as an Aquitard can be assessed by understanding the vertical gradients. The intermittent, lower hydraulically conductive clays coupled with the higher conductive sands produce conditions that will impact the flow lines. The flow lines become refracted as the groundwater attempts to move through and past the lower hydraulically conductive material towards higher conductive material. The angle of refraction for groundwater moving from high to low conductivity is directed perpendicular (downwards) to the direction of flow (Fetter, 1994). Therefore, the groundwater within the sands will likely be directed vertically downwards as it comes into contact with the till/clay layer.

The greater the vertical gradient between a monitoring well screened above the clay layer and a monitoring well screened below the clay layer indicates a tighter clay as it retards the downward movement (Bradbury and others, 2006). The vertical gradients were assessed for the nested wells throughout the area. Weston installed five well clusters with shallow, intermediate, and or deep screen intervals. The screen depths were placed in sand lenses between the clay layers at monitoring wells, WES-01abc, WES-02abc, WES-04ab, WES-05abc. Only WES-01ac had the highest average vertical gradient downward at four tenths of a foot (0.41 ft). The average vertical gradient for the other WES wells were between 0.01 and 0.07 ft. The average vertical gradient at most of these wells is downwards. There are no monitoring wells screened below the entire clay, which is estimated to be about 30 feet thick towards the southwest. From this evaluation, the first 15 feet of the clay might have only a weak ability to retard groundwater flow downwards at these locations.

The vertical gradients for nested well sets were determined for the dry and wet GWE data. This was then compared to the averaged vertical gradients from the cumulative GWE data. Figure 12 and 13 show vertical gradients for the dry and wet GWE data. Upwards vertical gradients are iso-contoured in yellow. Downwards vertical gradients are iso-contoured in red. The area has a mixture of upwards and downwards vertical flow due to the underlying heterogeneity. Slightly upward vertical flow occurs along Michigan Street at nested wells MMW-11S/D, MW-167S/D, MMW-P-10S/D, MMW-P-12S/D during the dry period with little to no downward vertical flow in the other nested wells (figure 16). During wet periods, the Michigan Plaza area becomes downward (0.1-0.38) (figure 17). On average, however, upwards vertical gradients primarily occur at locations north and northeast of Michigan Street (figure 18).

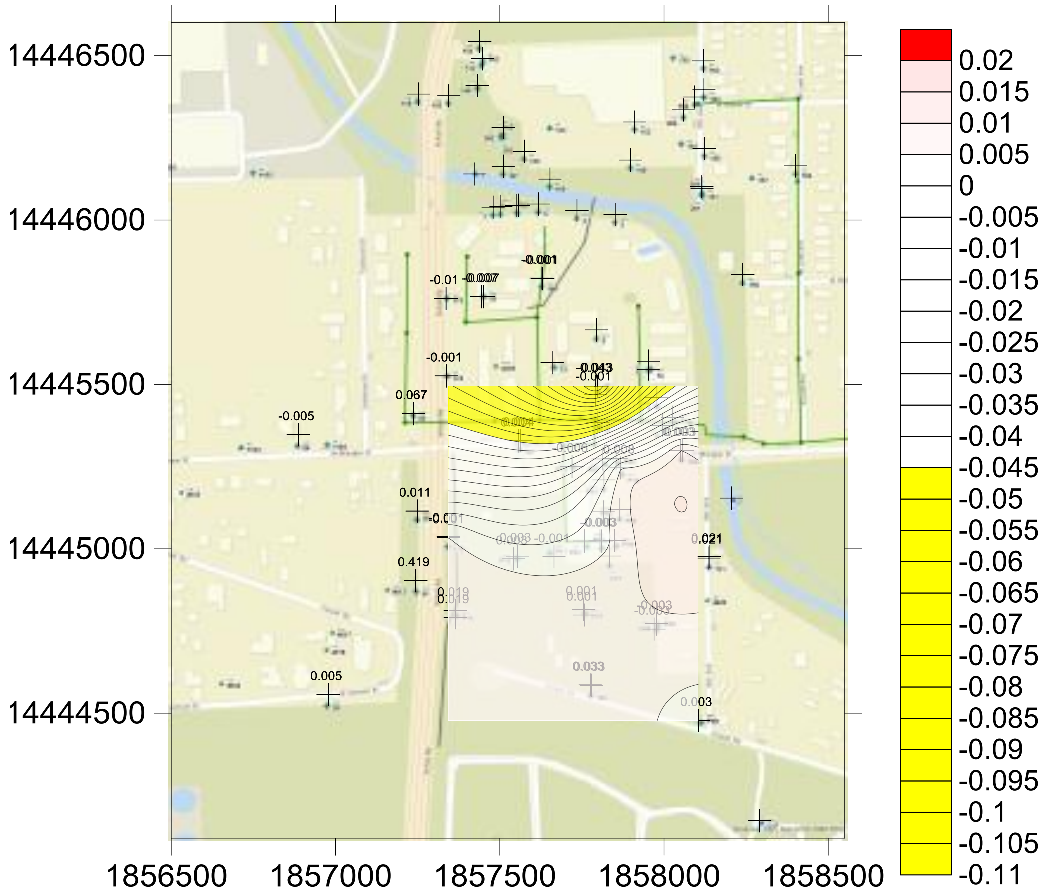


Figure 16. Dry period vertical gradient.

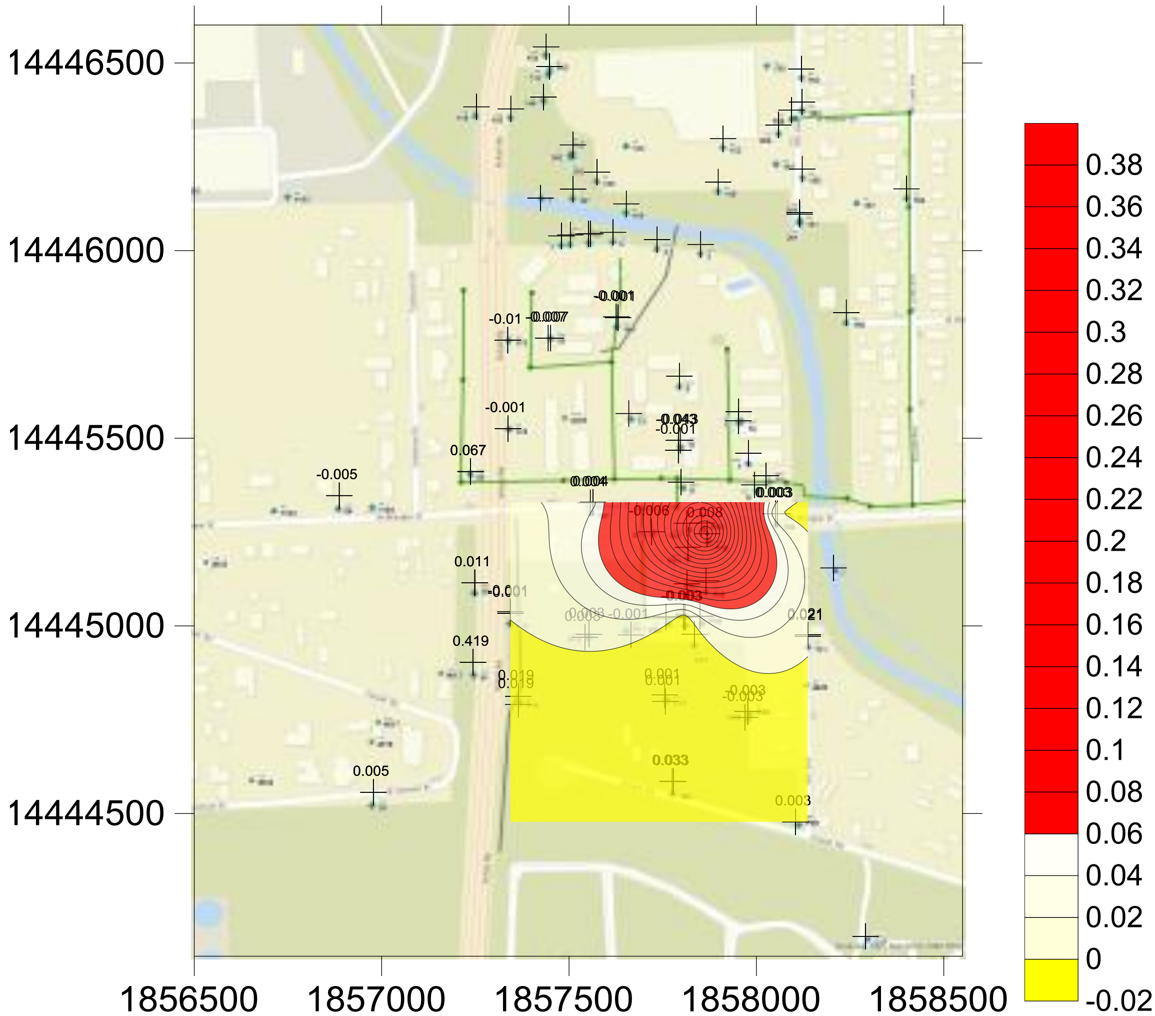


Figure 17. Wet period vertical gradient

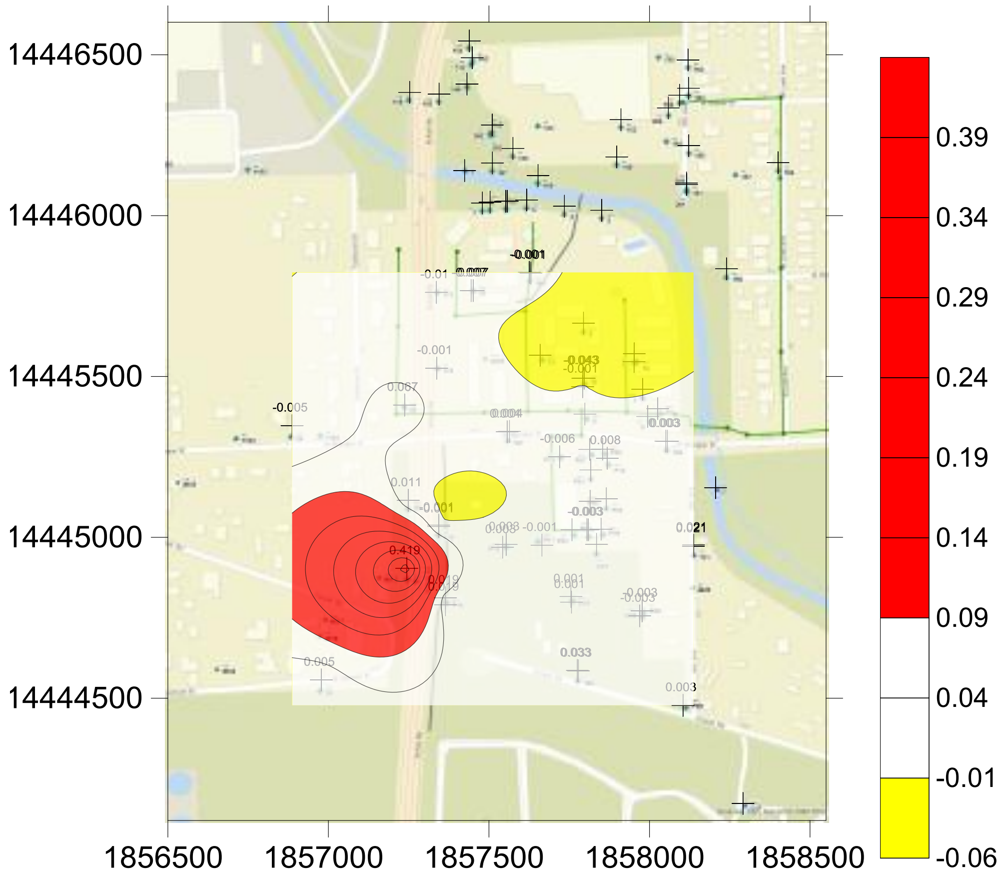


Figure 18. Averaged vertical gradients.

Localized groundwater flow has been shown to have variable spatial and temporal upward and downward vertical migration. On average, the vertical gradients are slightly upwards north of Michigan Street at Michigan Meadows Apartments and downwards near the residential wells. The upwards gradient increases during dry periods and reverses during wet periods. The area with the slightly greater downwards vertical migration could potentially direct contaminants downwards and into lower portions of the aquifer. The Weston wells have only a slight downward vertical gradient between the clay layers in that area along Holt Rd, therefore it may not be a substantial aquitard.

Water Quality Parameter (SpC)

Specific Conductance (SpC) value for seven separate periods in time were contoured to delineate possible locations of contamination and potential migration. Specific conductance is being used as a general proxy for the contaminants within the groundwater. The contaminants undergoing reductive dechlorination are steadily releasing chloride ions into the groundwater (Yu and Semprini, 2009). Conductivity increases substantially when chlorides are present (Schalk and Stasulis, 2012). The specific conductance recorded at each sampling site for each sampling year will be recording the temporal and spatial changes of specific conductivity at each well. These changes can potentially be used to delineate the plume areas and record any shifts in the plume.

The SpC iso-concentration maps are compared to PCE, VC and methane iso-concentration maps to confirm plume delineation using SpC and to potentially observe possible flow paths.

The first injection of edible oil treatment occurred around the same time as sampling (February 2007). This 2007 SpC data is the closest antecedent data available to help understand plume conditions before the edible oil treatments. The iso-concentration contours for specific conductance in 2007 indicate two separate plumes (figure 19). One plume at a separate contaminated site, Genuine Parts, and another plume underlying Michigan Plaza.

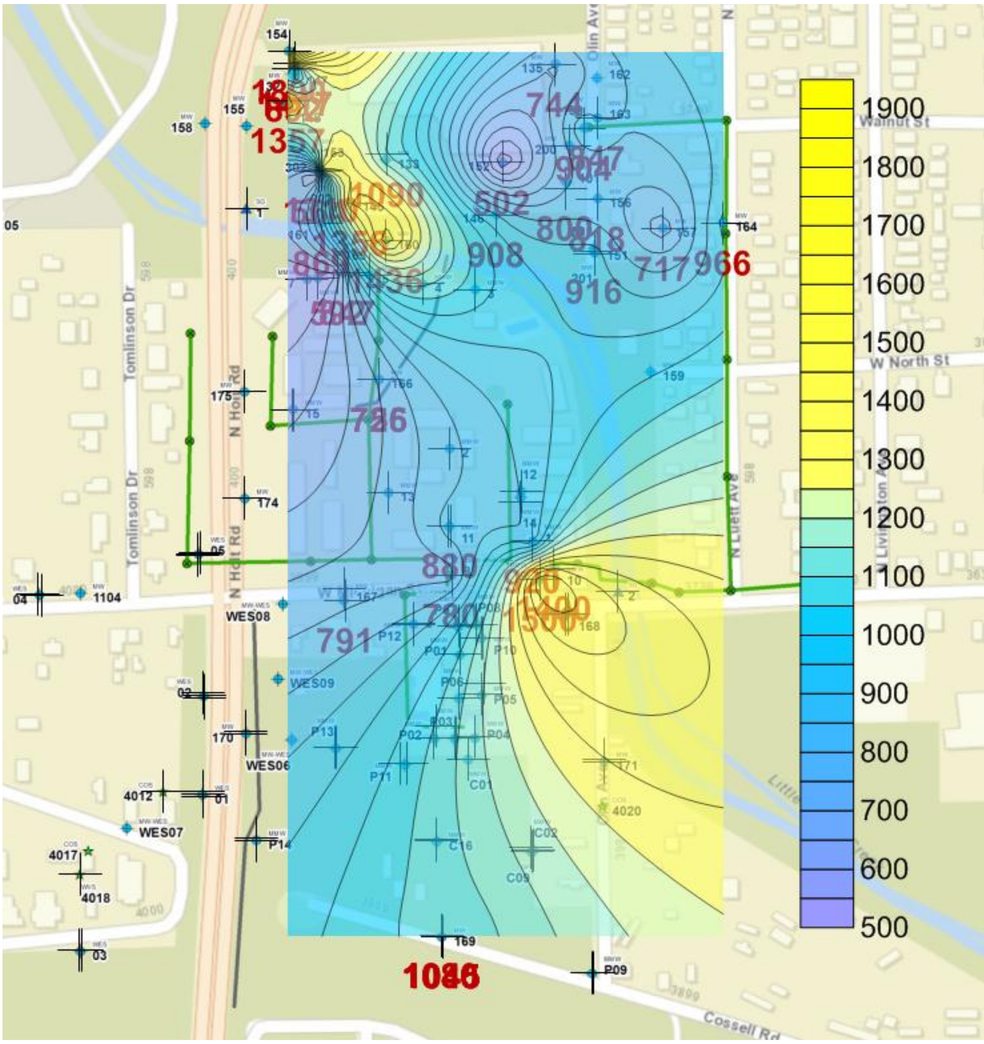


Figure 19. 2007 Specific Conductance iso-contours (SpC scale in µS/cm).

The iso-concentration contours for specific conductance in 2008 (figure 20) have highest values beneath Michigan Plaza Apartments and Michigan Plaza (3000-6000 µS/cm). There is a significant increase in specific conductance concentrations for the entire area. The high SpC value (8500 uS/cm) at the southeastern portion of the area (MW-P-9D) could be indicating an older plume migration from either Genuine Parts or Michigan Plaza or both.

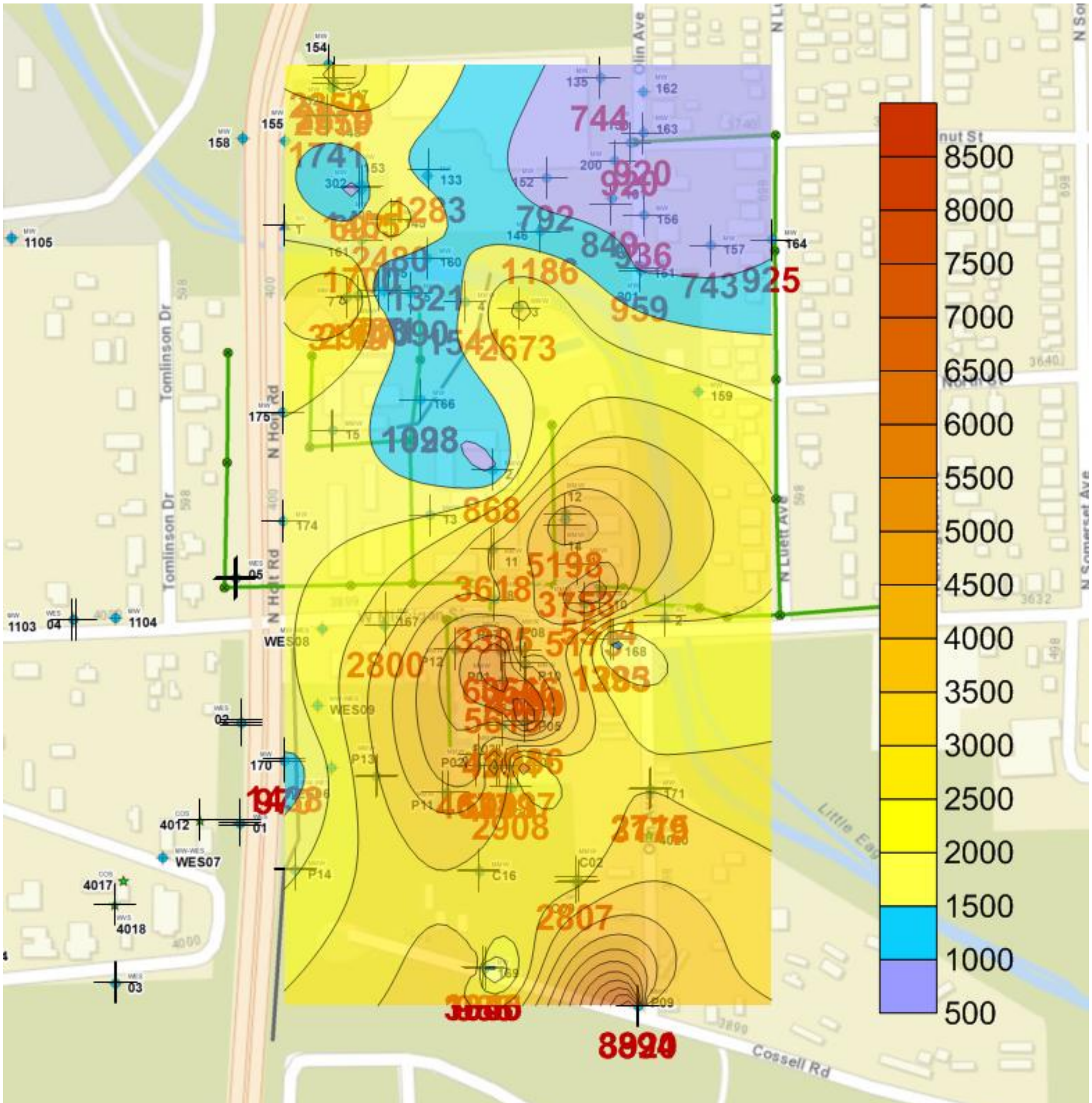


Figure 20. 2008 Specific Conductance Iso-concentration map (SpC scale in µS/cm).

Figure 21 depict the SpC iso-concentrations for 2009. The SpC iso-concentrations are higher near Genuine Parts and have a separation at Little Eagle Creek. The SpC increases at Michigan Apartments and Michigan Plaza near the source areas. There is an indication of migration towards the south and southeast.

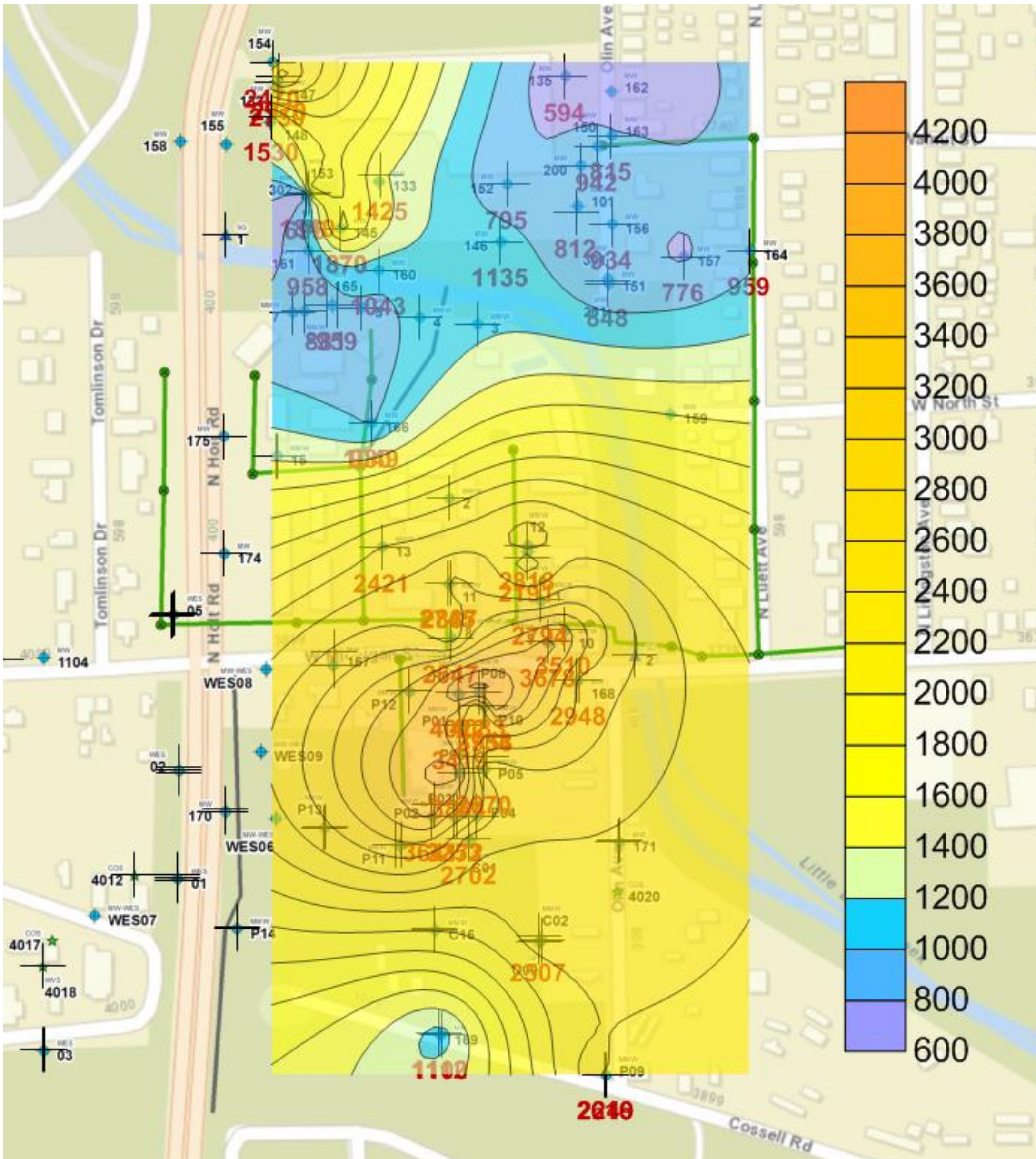


Figure21. 2009 Specific Conductance (SpC scale in µS/cm).

In 2010, (figure22) specific conductance dramatically declines to where only the highest SpC is at the source areas. There is a component of westward flow as indicated by the SpC in MW-170SD and MW-167S.

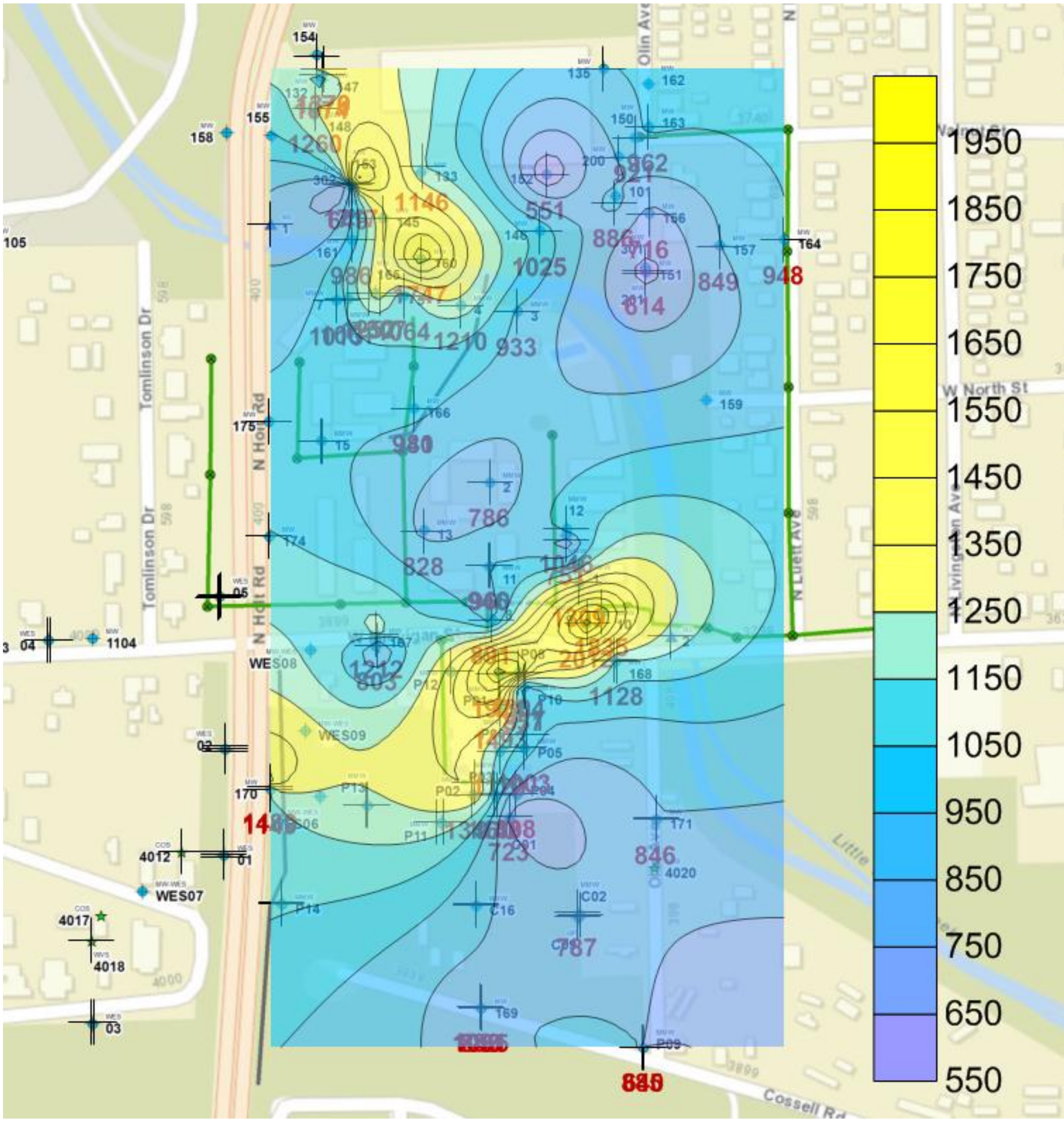


Figure22. 2010 Specific Conductance (SpC scale in µS/cm).

The iso-concentration for specific conductance in 2011 show three plume areas (figure 23). Genuine Parts to the north, Michigan Plaza on the East, and the addition of the Weston Wells completes the picture on the west, where increased SpC concentrations is found along Holt Rd and near the residential wells. The 2011 specific conductance data includes Weston's new wells near the residential area. SpC levels have decreased ~40% to a new range of 2000-3600 µS/cm. The SpC shows higher values beneath the Michigan Plaza and in the Weston wells MW-WES-02 and MW-WES-01. MW-170S had an increase in SpC from 1438 µS/cm in 2008 to 2735 µS/cm in 2011 possibly indicating a slight preferential pathway towards the west near the residential area.

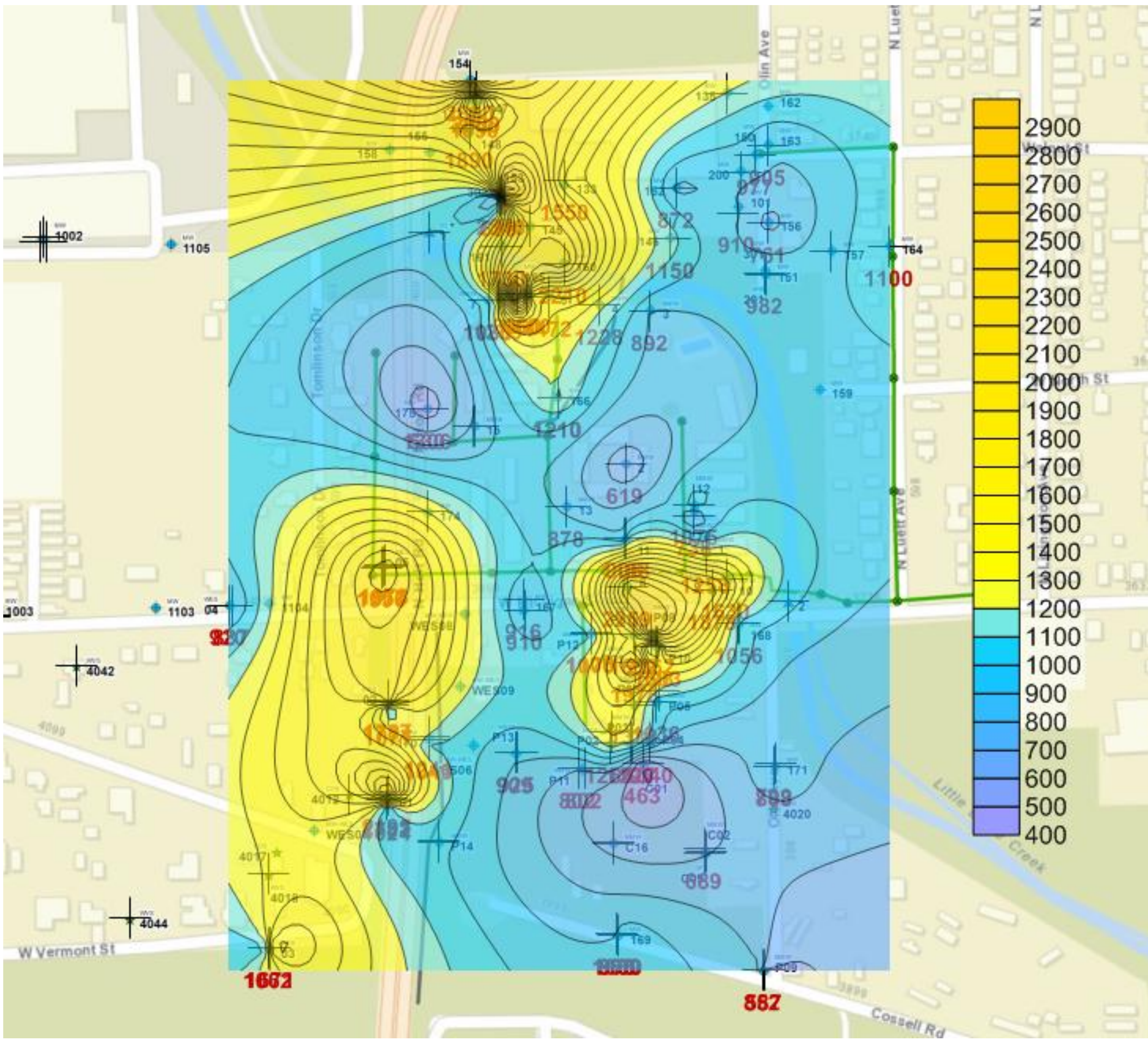


Figure 23. 2011 Specific Conductance iso-contour map (SpC scale in µS/cm).

In order to get a clear picture of what zones of the aquifer experienced the increase, the following figures show the SpC for the shallow, intermediate, and deep zones. The shallow zone indicates Michigan Plaza may have a slight westward component towards Holt Rd (figure 24).

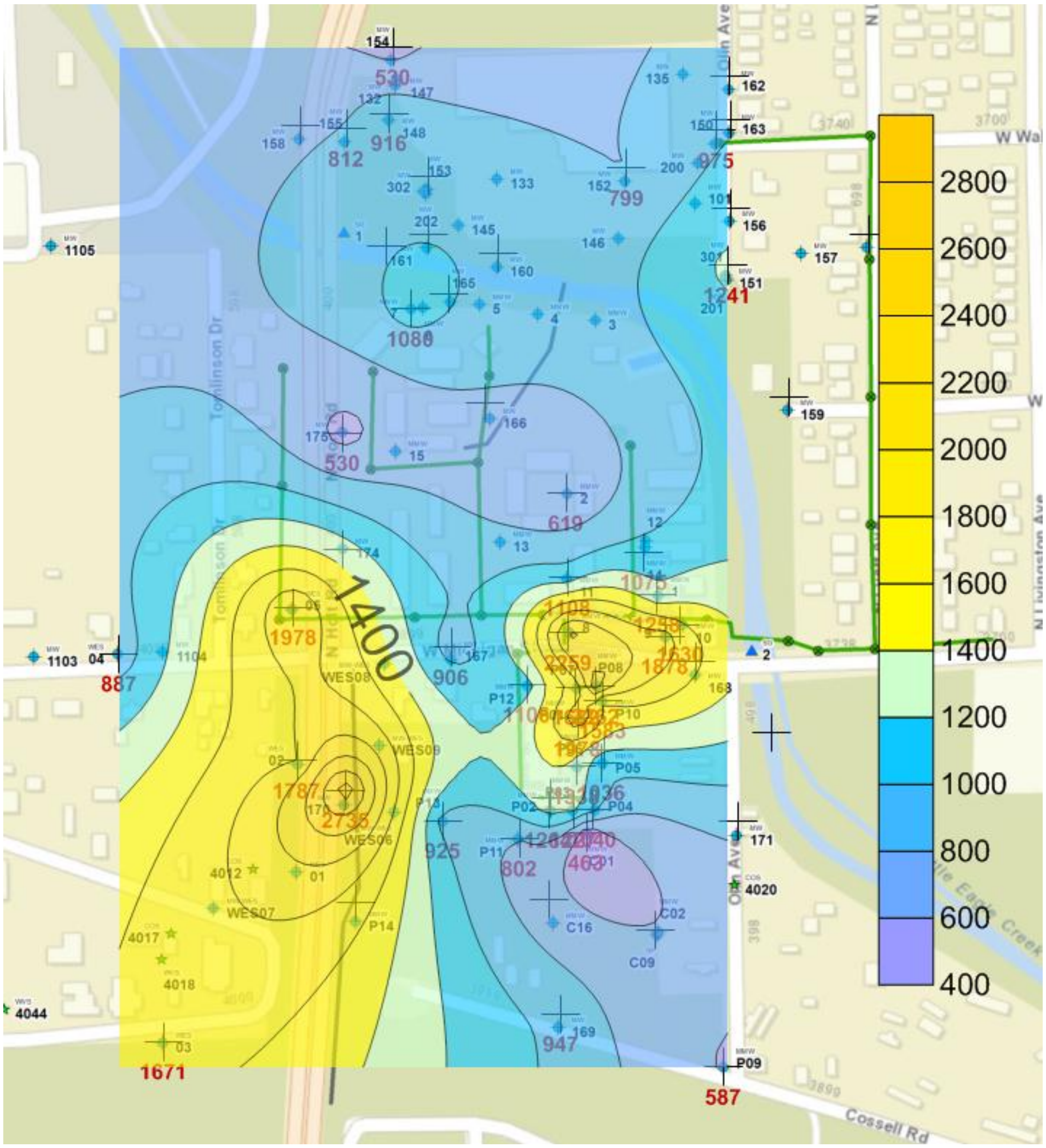


Figure 24. 2011 Shallow zone SpC iso-contour map (SpC scale in µS/cm).

Figure 25 shows the intermediate zone SpC iso-contours.

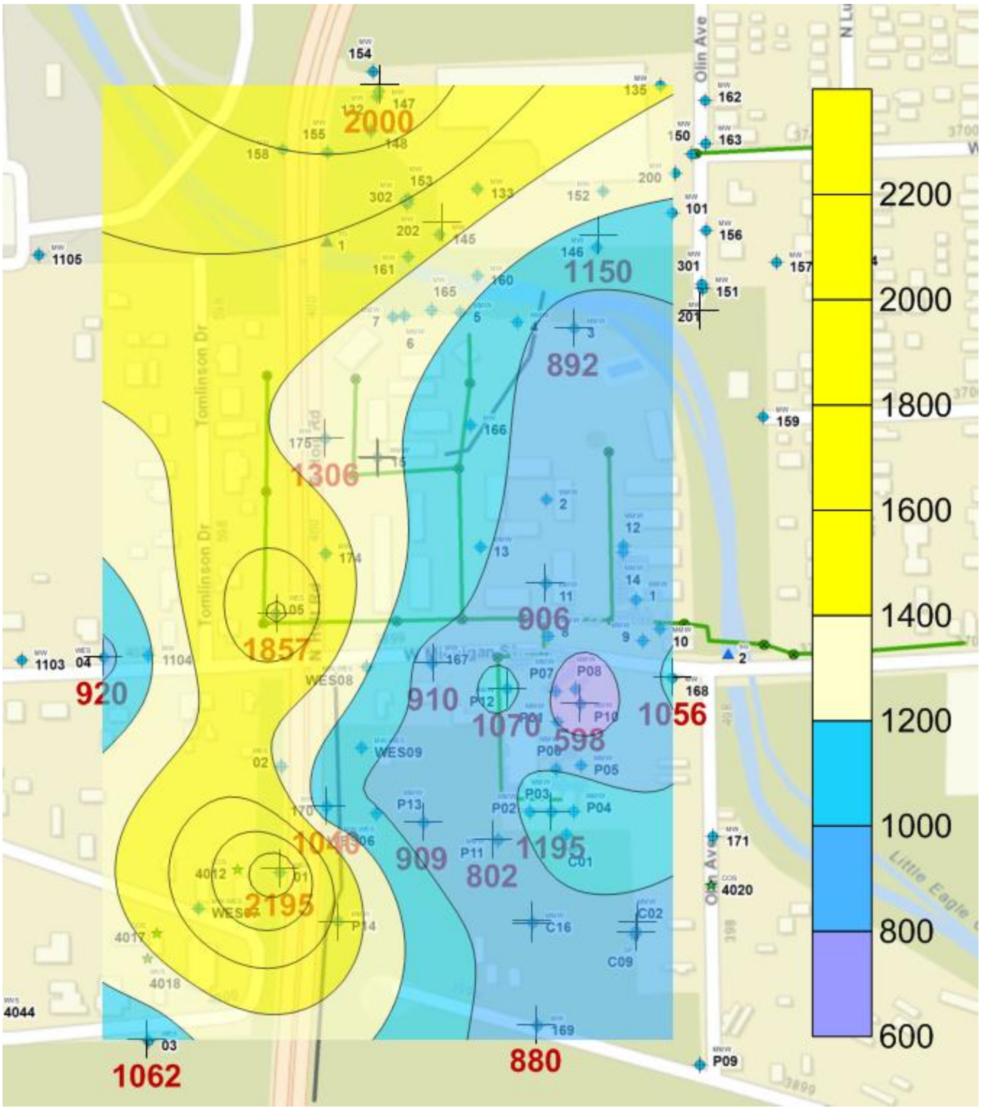


Figure25. Intermediate Zone Specific conductance iso-concentration (SpC scale in µS/cm).

It must be pointed out that the Michigan Plaza Area does not have any deep monitoring wells (<670 ft). Therefore, this presents a data gap for the deep zone of the aquifer in this area.

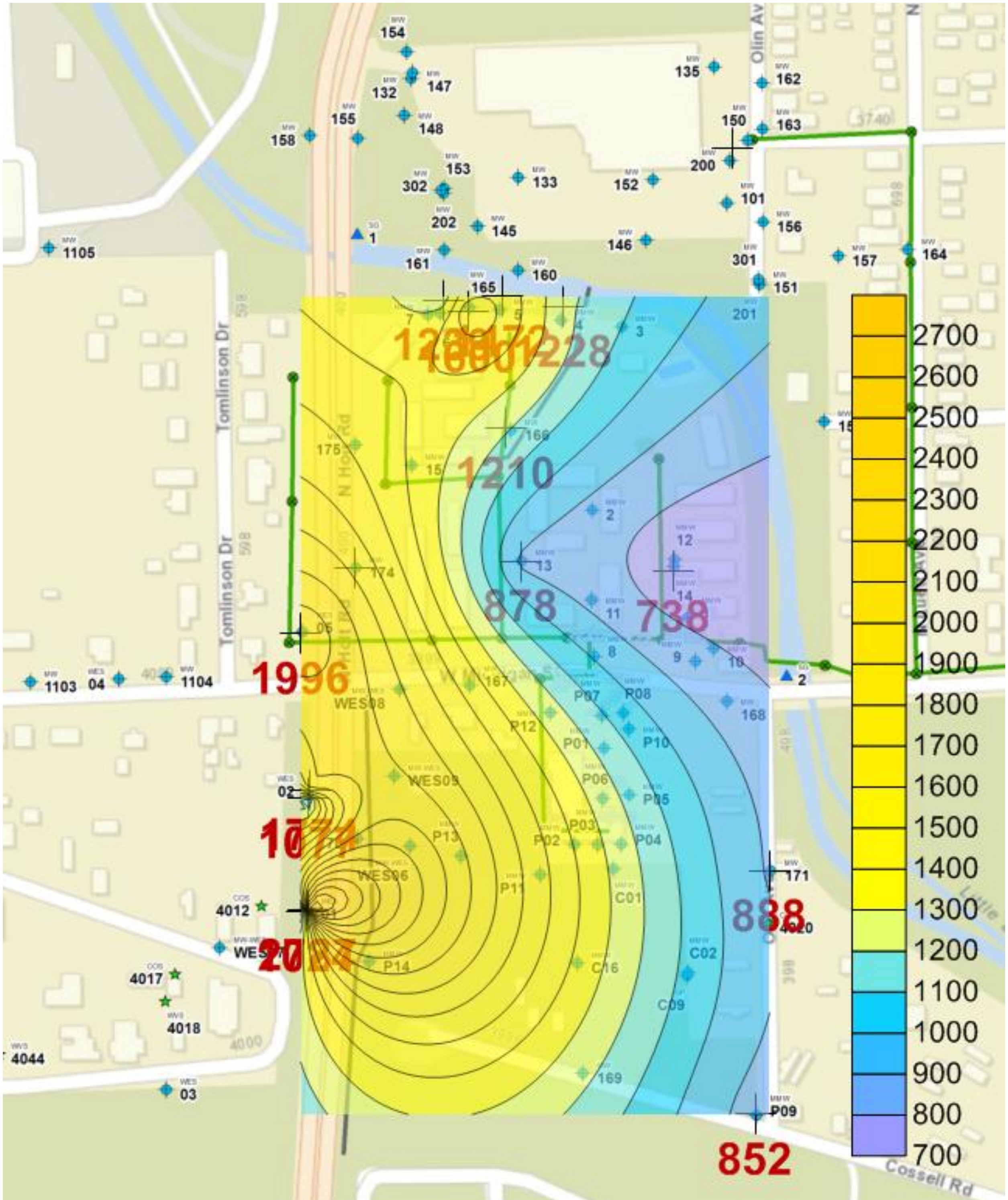


Figure 26. 2011 Deep zone specific conductance iso-concentration. Note the lack of deep monitoring wells south of Michigan Plaza (SpC scale in µS/cm).

In 2012, the newer monitoring wells (WES-xx), west of Holt Rd were not sampled. This presented a slight data gap. MW -170 S/D and P-14 are intermediate wells along the east side of Holt Rd and both were sampled in 2012. Both have elevated SpC concentrations. Figure 27 shows a general decrease in SpC concentration with the highest concentration detected at 1857 uS/cm. The areas with the highest SpC were still detected near the plume sources and also westward at MW167S and MW-170 S and D. The SpC data indicate two possible pathways, from both Genuine Parts (MW-166-D and MMW-4 D) and from Michigan Plaza (P-12-I and MW-167S).

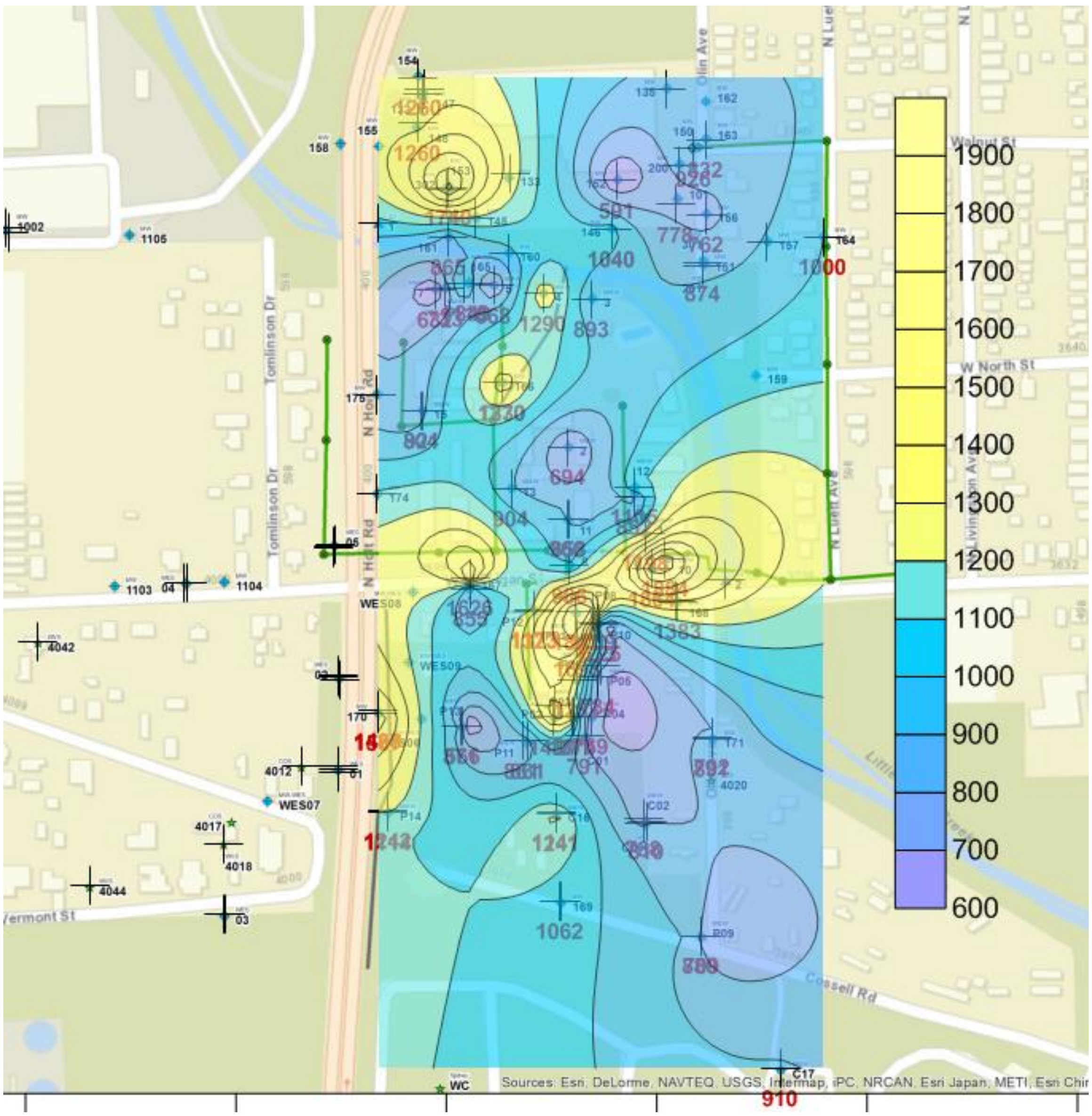


Figure 27. 2012 SpC iso-concentration map (SpC scale in µS/cm).

There are two separate figures for 2013, May and September. There have been a total of three injections of edible oil treatment to increase the rate of biodegradation. The first injection occurred in February of 2007. Another treatment occurred in August of 2009 and, more recently, in July 2013. The May 2013 (figure 28) (nearly four years post injections) and September 2013 specific conductance data is contoured to determine the effect injections may have.

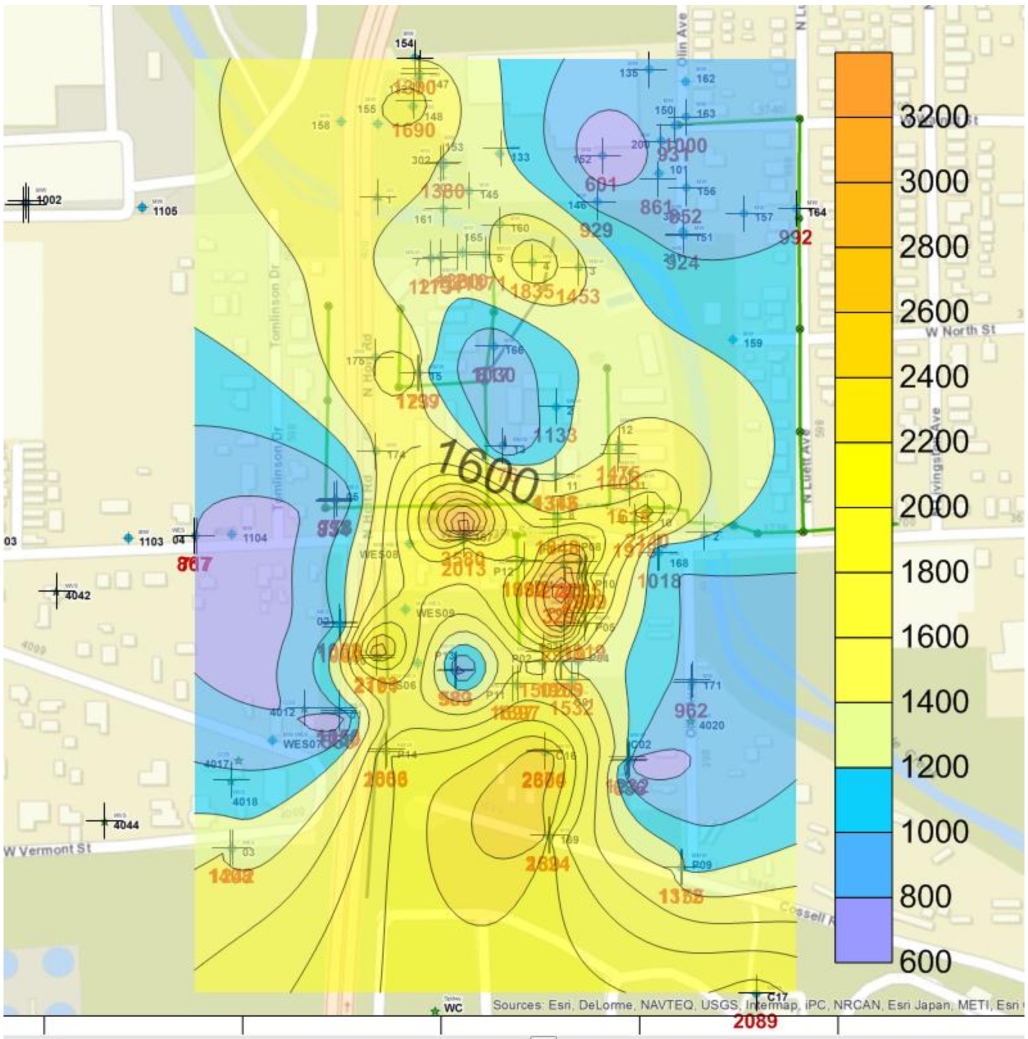


Figure 28. May 2013, SpC iso-concentration prior to edible oil injection (SpC scale in µS/cm).

Following the edible oil injections, the specific conductance decreased dramatically (figure 29). Plume areas still have elevated SpC concentration, but only between 1200 to 1900 uS/cm. There remains slightly elevated SpC along the Holt Rd monitoring wells and Weston wells. The decrease in SpC is also observed for the 2009 injections. Prior to the injections in August of 2009, the March 2009 specific conductance had been as high as 4200 uS/cm in the source areas. After the injections, the specific conductance is only as high as 2224 uS/cm at monitoring well P-07 which is directly within the source. This decrease is likely caused by the lower conductivity fluid (edible oil) mixing with the groundwater and reducing the overall conductivity of the aquifer. This decrease is followed by a slow increase in specific conductance values as the edible oil is used up by the microbes and biodegradation increases the chloride ions within the aquifer. It had taken approximately 4 years for the specific conductance to increase.

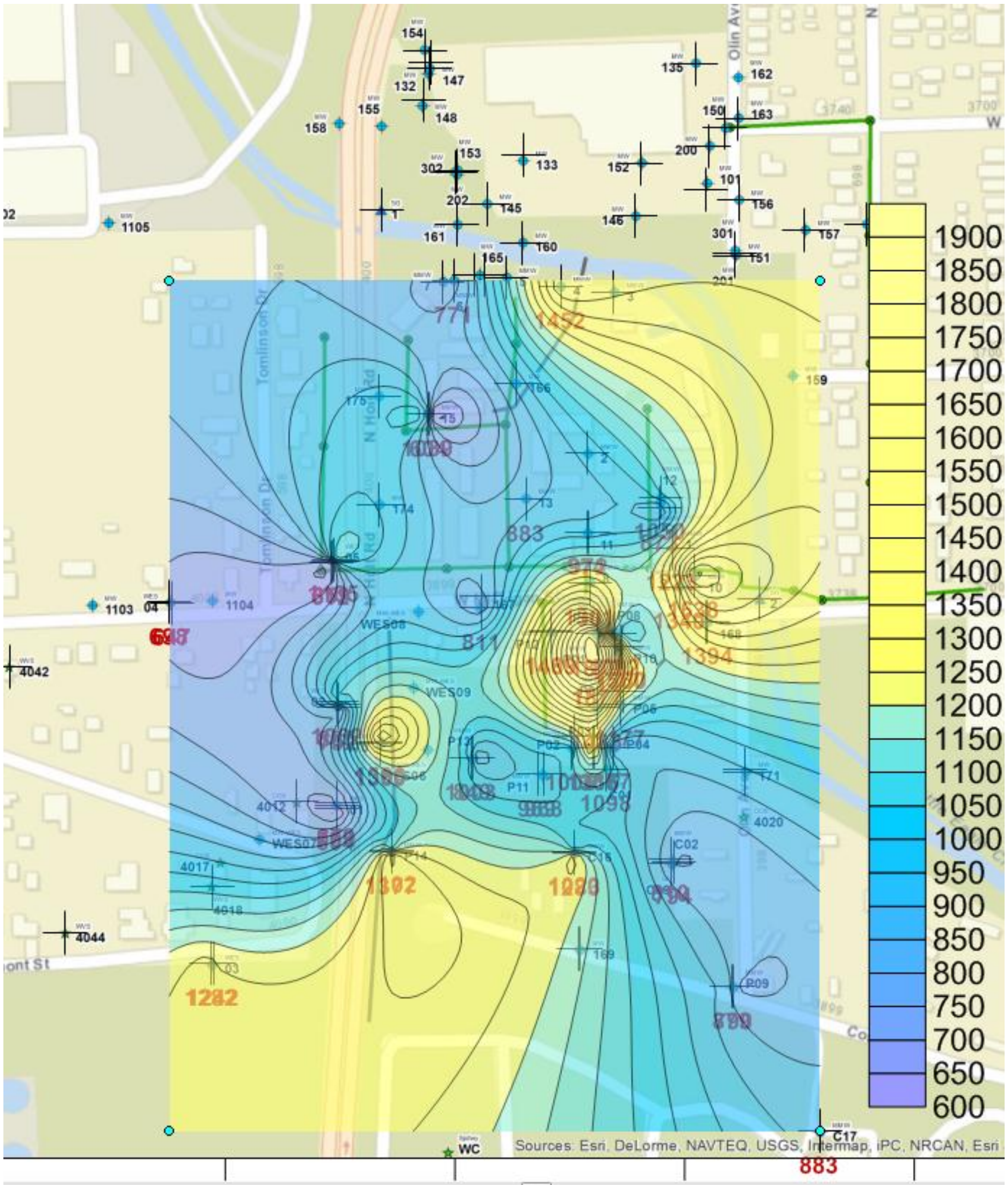


Figure 29. September 2013 SpC iso-contours, two months post edible oil injections (SpC scale in µS/cm).

Water Quality: PCE, VC and methane

Figure 30 depicts the PCE concentration detected above the MCL. PCE is detected at the Michigan Plaza and Michigan Apartments source area. It is also detected at WES-01c at a concentration of 6.0 ug/l in June 2013 and again in October 2013 at 7.4 ug/l. A residential well (RES-4044) had a one-time detection of PCE at a concentration of 3 ug/l in July of 2010. These are both deep wells (<670 ft). It is interesting to note that migration of PCE has not occurred anywhere else except towards the west. It is also important to note that there are no deep wells located at the PCE source area. The PCE has only been confirmed to be in the shallow and intermediate zones. PCE may also exist at greater depths within the source area. At 675 to 670 ft elevation, there is a clay layer with variable thickness from 5 to 30 ft. This clay layer has not been penetrated near the Michigan Plaza area, therefore the thickness and integrity is unknown.

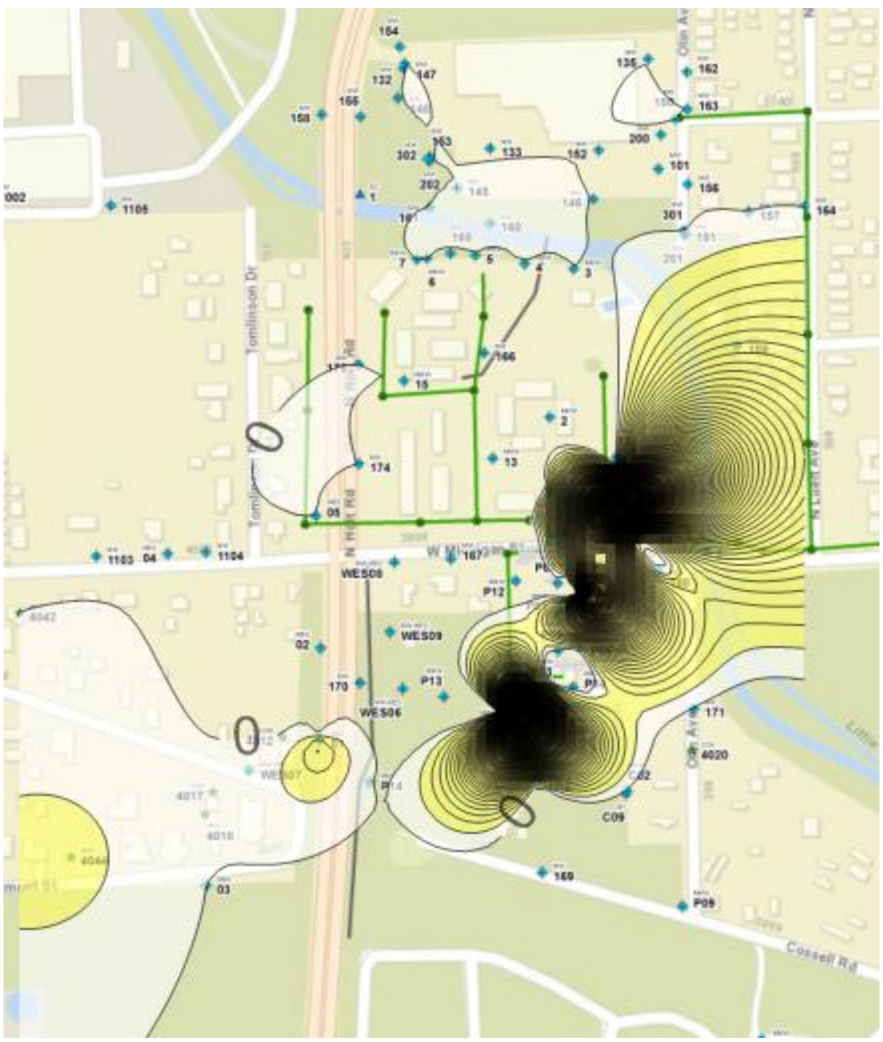


Figure 30. PCE detections above MCL (2 ug/l)

Vinyl chloride detects above the MCL (2 µg/l)are contoured in figure 31. Due to the large range in concentrations, the log (base 10) of the concentrations were contoured. The locations where there is blue and purple are non-detects. The majority of the non-detects in the southern half are all shallow monitoring wells. A migration pathway appears to follow along south and southwest at the intermediate and deep zones.

The VC iso-concentration map closely resembles the maps created with the SpC. The SpC maps depict a lack of VCs in the shallow zone along the southern half. However, a look at the individual zones (figures 24 through 26) does show higher SpC in the intermediate and deep zones and lower SpC in the shallow zone along the southeast portion of the area.

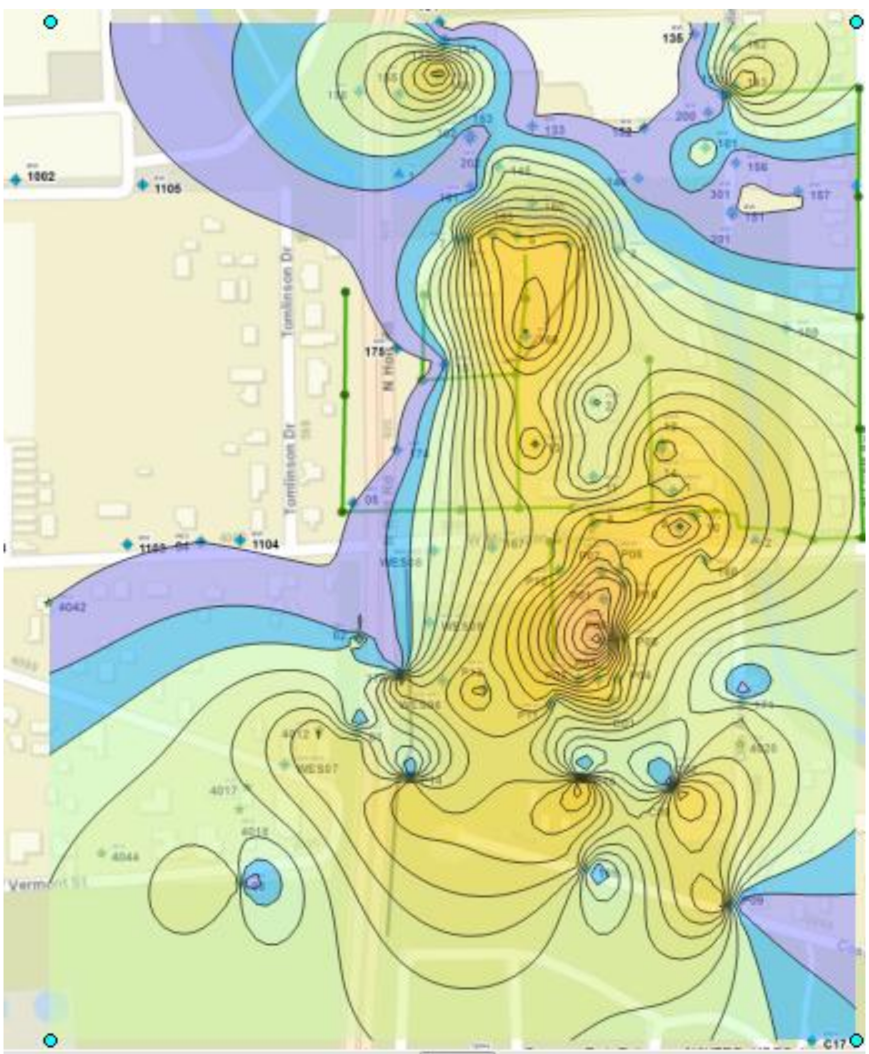


Figure 31. All Vinyl Chloride Concentration above the MCL (2 ug/l)

Methane

The addition of edible oil treatment in the Michigan Plaza and Michigan Apartments Source Areas A, B and C has created a substantial amount of methane. Concentrations of methane are highest (1,403-29,800 ug/l) at the Source Areas. Genuine Parts, historically, never tested for methane, therefore there is no information for methane concentrations on that site. EPA recently tested for methane in a few of the Genuine Parts wells and only one well (MW301) had a detection of methane at 92 µg/L. In Figure 32, the oldest available methane concentrations were contoured to try and assess conditions before the edible oil injections. Methane had not been sampled everywhere until 2013. Also, Mundell only samples a limited set of monitoring wells for dissolved methane. This creates many data gaps and limits any interpretations on the actual extent of the methane before and during 2013 sampling. Figure 32 has elevated concentrations of methane primarily at the source areas with a concentration range from 18 µg/l to 16,000 µg/l.

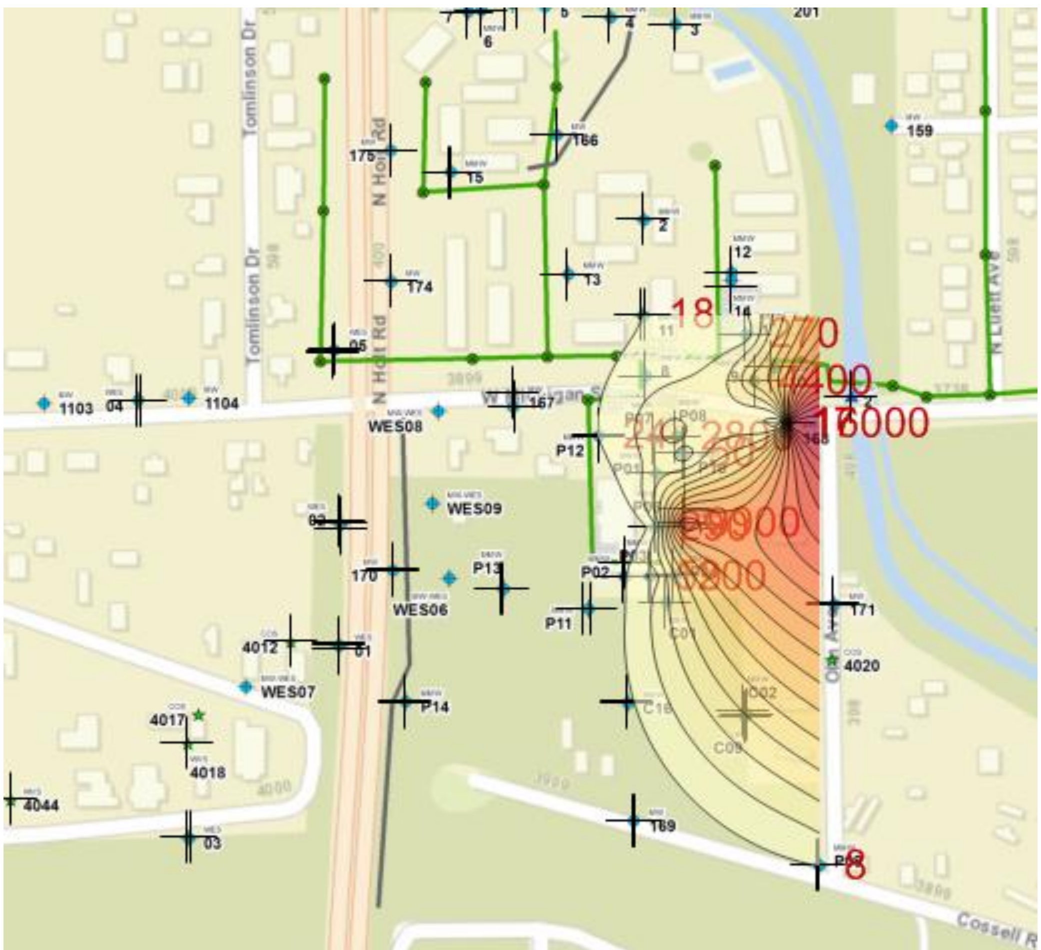


Figure 32. Oldest Available Methane concentrations for the Source Areas A, B and C.

Figures 33 through 34 show the progression of methane from 2011 through 2013. The earlier figures from 2011 and 2012 indicate an increase in methane at the source areas.

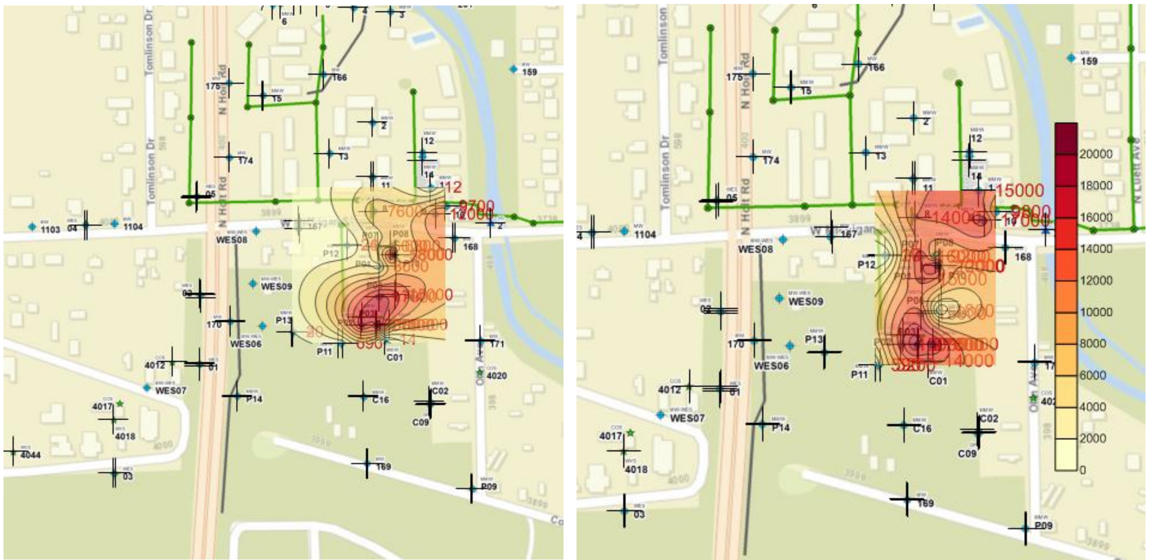


Figure 33 and 34. May 2011 Methane (left) and August 2012 Methane (right) iso-concentration maps (Methane scale is µg/l).

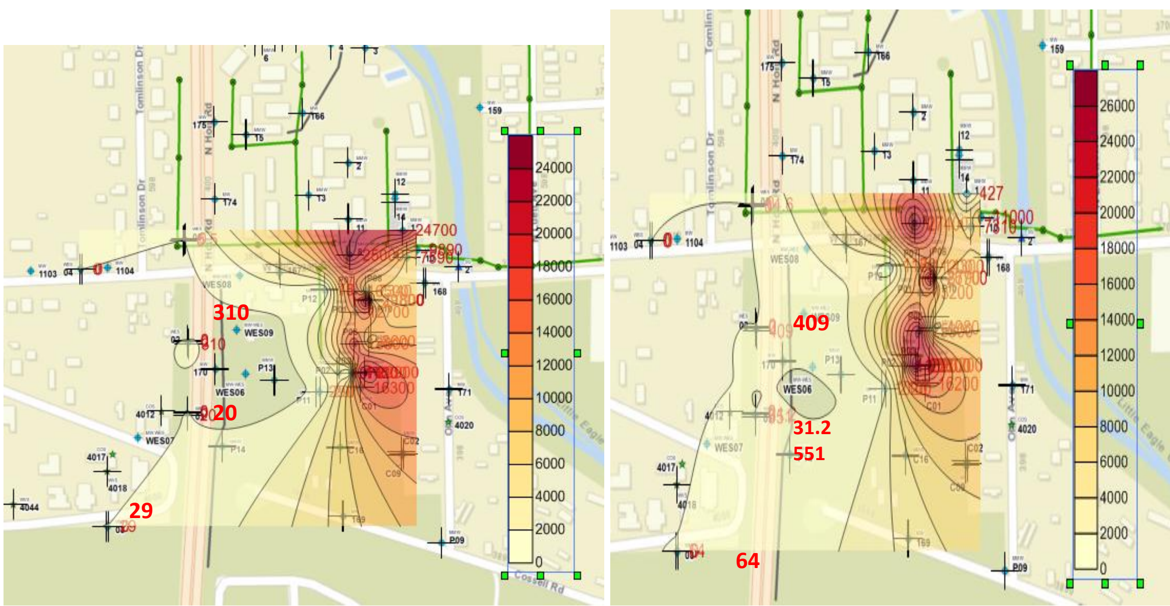


Figure 35 and 36. September 2013 Methane (left) and November 2013 Methane (right) (Methane scale is µg/l).

Figure 35 and 36 above are two methane sampling events for that year. The methane has spread westward. It is also interesting to note that the shallow wells along the west (Holt Rd) are all non-detects, but the intermediate and deep wells are showing detections. The data is still severely lacking to be able make any interpretations apart from a general increase in methane and some possible expansion westward.

Summary

The transient groundwater elevation data depicted at the local, intermediate and regional scale show evidence of some potential for a westward flow direction, particularly, north of Michigan St. The groundwater flow direction has radial flow in the shallow and intermediate aquifer zones north of Michigan Street. The flow resumes a south-southeasterly flow direction south of the Michigan Plaza area. Periods of high and low groundwater elevations have the potential to exacerbate the radial flow and shift it westward. It is not apparent that the westward flow component is a dominant preferential pathway. The vertical gradients indicate a mixture of upwards and downwards vertical flow which is attributed to the subsurface heterogeneity. The modest downward vertical gradient at the Weston monitoring wells may indicate that at least the first 15 feet of the clay is not protective enough to be considered an Aquitard.

The specific conductance is in agreement with the groundwater elevation flow path analysis, particularly at the Intermediate Scale, where some wells have increases in SpC along the radial flow near Michigan Street and along the westward component near MW-170, WES-01, and WES-02. The higher specific conductance data and detected PCE, VC and methane in some of the wells along Holt Rd and near the residential area suggest there is a pathway or a diversion of groundwater flow around the heterogeneous till and into preferential pathways along Holt Rd. The extent of this pathway towards the affected residents COS4017 and RES4018 may be limited as indicated by the slightly lower SpC when compared to the other more impacted wells. The Vinyl Chloride plume depicted is comingled with the Genuine Parts plume. Much of the data indicates that a significant amount of VC is migrating from the Genuine Parts site south along Holt Rd at the intermediate and deep zones of the aquifer. PCE and methane are detected at substantially higher concentrations at the Michigan Plaza/Apartments source areas and is possibly migrating off the Michigan Plaza along localized westward flowpaths. This preferential flowpath is made evident by the absence of detected PCE, VC and methane in the shallow wells south of the Michigan Plaza. Contaminants are only detected in the intermediate and deep wells, suggesting a preferential flow path at these elevations.

References Cited

Beodray, Frank, 2013, Technical Memorandum Analytical and Hydrogeological Evaluation West Vermont Street Site Speedway, Marion County, Indiana, Weston Solutions, Inc., Technical Direction Document No. S05-0001-1205-013

Bradbury, K,R, M.B. Gotkowitz, D.J. Hart, T.T. Eaton, J.A. Cherry, P,L. Parker, and M.A. Borchardt. 2006. Contaminant Transport Through Aquitards: Technical Guidance for Aquitard Assessment. Published by American Water Works Association (AWWA) Research Foundation, and International Water Well Association (IWA) Publishing.

Chapelle, F.H., Novak, John, Parker, John, Campbell, B.G., and Widdowson, M.A., 2007. A framework for assessing the sustainability of monitored natural attenuation: U.S. Geological Survey Circular 1303, 35 p. http://pubs.usgs.gov/circ/circ1303/pdf/circ1303.pdf

Christensen, V.G., J. Xiaodong, and A.C. Ziegler. 1999. Regression analysis and real-time water quality monitoring to estimate constituent concentrations, loads, and yields in the Little Arkansas River, South-Central Kansas, 1995-1999. U.S. Geological Survey, Water-Resources Investigations Report 00-4126.

Degnan, J.R., and Brayton, M.J., 2010, Preliminary investigation of paleochannels and groundwater specific conductance using direct-current resistivity and surface-wave seismic geophysical surveys at the Standard Chlorine of Delaware, Inc., Superfund Site, Delaware City, Delaware, 2008: U.S. Geological Survey Open-File Report 2010–1058, 27 p., at http://pubs.usgs.gov/of/2010/1058/.

Focazio, Michael J., Reilly, Thomas E., Rupert, Michaeil G., Helsel, Dennis R. 2002. Assessing Ground-Water Vulnerability to Contamination: Providing Scientifically Defensible Information for Decision Makers,. U.S. Geological Survey Circular 1224. http://pubs.usgs.gov/circ/2002/circ1224/pdf/circ1224_ver1.01.pdf

Grove, Glenn E., 2012, Potentiometric Surface Map of the Unconsolidated Aquifers of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. http://www.in.gov/dnr/water/files/19_Marion_County_UNC_PSM_map.pdf

Grove, Glenn E., 2012, Potentiometric Surface Map of the Bedrock Aquifers of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. http://www.in.gov/dnr/water/files/19_Marion_County_BED_PSM_map.pdf

Henry, Bruce. 2010. Loading Rates and Impacts of Substrate Delivery for Enhanced Anaerobic Bioremediation. Environmental Security Technology Certification Program. http://clu-in.org/download/contaminantfocus/dnapl/Treatment_Technologies/ER-0627-FR-1.pdf

ITRC (Interstate Technology & Regulatory Council). 2008. *In Situ Bioremediation of Chlorinated Ethene: DNAPL Source Zones.* BioDNAPL-3. Washington, DC: Interstate Technology & Regulatory Council, Bioremediation of DNAPLs Team www.itrcweb.org

ITRC (Interstate Technology & Regulatory Council). 1999. *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices.* Washington, D.C.: Interstate Technology & Regulatory Cooperation Work Group In-Situ Bioremediation Work Team www.itrcweb.org

Kunze, A.E. and B.N. Sroka. August 2004. Effects of highway deicing chemicals on shallow unconsolidated aquifers in Ohio—Final report. U.S. Geological Survey, Report No. FHWA/OH-2004/009.

Marin, Luis E., Steinich, B., Escolero, Oscar, Leal, Rosa Maria, Silva, Braulio, Gutierrez, Susana. 1998. Inorganic Water Quality Monitoring using Specific Conductance in Mexico, Winter GWMR, pages 156-162. http://info.ngwa.org/gwol/pdf/980263405.PDF

Prince, Keith R., Franke, O. Lehn., Reilly, Thomas E., 1988, Quantitative Assessment of the Shallow Groundwater Flow System Associated with Connetquot Brook, Long Island, New York: U.S. Geological Survey Water-Supply Paper; 2309 http://pubs.usgs.gov/wsp/2309/report.pdf

Schalk, C.W., and Stasulis, N.W., 2012, Relations among water levels, specific conductance, and depths of bedrock fractures in four road-salt-contaminated wells in Maine, 2007–9: U.S. Geological Survey Scientific Investigations Report 2012–5205, 47 p., available only at http://pubs.usgs.gov/sir/2012/5205.

Schmidt, Robert K., 2011, Unconsolidated Aquifer Systems of Marion County, Indiana, IDNR, Division of Water, Resource Assessment Section, scale 1:24,000. *http://www.in.gov/dnr/water/files/81_Marion_County_UNC_AQSYS_map.pdf*

Smith, Richard L., Harvey, Ronald W., LeBlanc, Denis R., 1991, Importance of closely spaced vertical sampling in delineating chemical and microbiological gradients in groundwater studies, *Journal of Contaminant Hydrology*, 7 (1991) 285-300

U.S. Geological Survey, 2010, Anoxic definition, Volatile Organic Compounds in the Nation's Ground Water and Drinking-Water Supply Wells: Supporting Information http://water.usgs.gov/nawqa/vocs/national_assessment/report/glossary.html

U.S. Geological Survey, 1995, Surface-Water-Quality Assessment of the Lower Kansaa River Basin, Kansas and Nebraska-Analysis of Available Data Through 1986. Editors P.R. Jordan and J.K. Stamer, U.S. Geological Survey Water-Supply Paper 2352-B

Winter, Thomas C., Harvey, Judson W., Franke, O. lehn, Alley, William M., 1998, Groundwater and Surface Water A Single Resource, US Geological Survey circular: 1139 http://pubs.usgs.gov/circ/circ1139/htdocs/boxg.htm

Yu, Seungho and Lewis Semprini. 2009. Enhanced reductive dechlorination of PCE DNAPL with TBOS as a slow-release electron donor. *Journal of Hazardous Materials* Vol 167, Issues 1-3, pp. 97-104. http://www.sciencedirect.com/science/article/pii/S0304389408019389

Data obtained from the following Reports/Documents:

Michigan Plaza Quarterly Monitoring Progress Report, 3rd Quarter, 2013 (October 31, 2013) Mundell Consulting Professionals for the Earth and the Environment, Mundell Project No. M01046.

Lam, Shelly (November 12, 2013) "Supporting Documentation Meeting with AIMCO" U.S. EPA Letter Report, West Vermont Drinking Water Contamination Site Indianapolis, Indiana.

2007-2011 Field Data Sheets from Keramida Environmental, INC. Genuine Parts Site Data.

Purge Logs Sept, July, June, Oct, Aug 2013 from Weston.

MW Sampling Logs 12072011 through 12122011 from Weston.

Tables in 09272013 Remediation Work Plan from Mundell.

AIMCO-Mundell Technical Response to EPA January 2013 Technical Memorandum April 18, 2013.

Appendix

Table 1-1. Monitoring Well Construction Data

Monitoring Well	Site/well owner	x	y	Top of Casing Elevation	Depth to Top of Screen	Depth to Bottom of Screen	Total Depth	Top of Screen Elevation	Bottom of Screen Elevation	Aquifer Zone
MW-WES-01a	USEPA	1857244	14444903	716.13	32.5	37.5	37.5	683.63	678.63	I
MW-WES-01b	USEPA	1857244	14444903	716.05	41	46	46	675.05	670.05	D
MW-WES-01c	USEPA	1857244	14444903	715.96	50	55	55	665.96	660.96	D
MW-WES-02a	USEPA	1857249	14445115	716.24	24	29	29	692.24	687.24	S
MW-WES-02b	USEPA	1857249	14445115	716.28	35	40	40	681.28	676.28	D
MW-WES-02c	USEPA	1857249	14445115	716.23	40	50	50	676.23	666.23	D
MW-WES-03a	USEPA	1856978	14444557	717.42	30	35	35	687.42	682.42	S
MW-WES-03b	USEPA	1856978	14444557	717.41	40	45	45	677.41	672.41	I
MW-WES-04a	USEPA	1856887	14445347	717.85	30	35	35	687.85	682.85	S
MW-WES-04b	USEPA	1856887	14445347	717.85	40	45	45	677.85	672.85	I
MW-WES-05a	USEPA	1857237	14445411	717.04	20	25	25	697.04	692.04	S
MW-WES-05b	USEPA	1857237	14445411	716.6	32.5	37.5	37.5	684.1	679.1	I
MW-WES-05c	USEPA	1857237	14445411	715.95	45	50	50	670.95	665.95	D
MMW-10S	Michigan Plaza	1858026	14445400	712.69	15	25	25	697.69	687.69	S
MMW-11D	Michigan Plaza	1857792	14445494	713.33	23	33	36	690.33	680.33	I
MMW-11S	Michigan Plaza	1857797	14445494	713.17	14	24	24	699.17	689.17	S
MMW-12S	Michigan Plaza	1857953	14445571	712.15	14	24	24	698.15	688.15	S
MMW-13D	Michigan Plaza	1857659	14445566	713.28	35	50	50	678.28	663.28	D
MMW-14D	Michigan Plaza	1857952	14445546	712.41	40	50	50	672.41	662.41	D
MMW-1S	Michigan Plaza	1857979	14445460	712.92	10	20	20	702.92	692.92	S
MMW-2S	Michigan Plaza	1857794	14445666	712.95	10	20	20	702.95	692.95	S
MMW-3S	Michigan Plaza	1857851	14446017	710.2	20	30	30	690.2	680.2	I

MMW-4D	Michigan Plaza	1857735	14446029	711.29	56	66	66	655.29	645.29	D
MMW-5D	Michigan Plaza	1857618	14446049	711.27	41	51	51	670.27	660.27	D
MMW-6D	Michigan Plaza	1857503	14446042	712.4	41	51	51	671.4	661.4	D
MMW-7S	Michigan Plaza	1857480	14446039	712.09	16	26	26	696.09	686.09	S
MMW-8S	Michigan Plaza	1857799	14445383	714.24	14	24	24	700.24	690.24	S
MMW-9S	Michigan Plaza	1857995	14445376	713.71	15	25	25	698.71	688.71	S
MMW-C-01	Michigan Plaza	1857835	14444978	715.73	18	28	28	697.73	687.73	S
MMW-C-02	Michigan Plaza	1857977	14444772	714.64	18	28	28	696.64	686.64	S
MMW-P-01	Michigan Plaza	1857817	14445209	715.26	18	28	28	697.26	687.26	S
MMW-P-02	Michigan Plaza	1857759	14445024	716.09	20	30	30	696.09	686.09	S
GP-02	Michigan Plaza	1857759	14445024	716.09	20	30	30	696.09	686.09	S
MMW-P-03D	Michigan Plaza	1857805	14445024	716.02	25	35	40	691.02	681.02	I
MMW-P-03S	Michigan Plaza	1857809	14445024	715.95	18	28	28	697.95	687.95	S
MMW-P-04	Michigan Plaza	1857849	14445025	716.04	18	28	20	698.04	688.04	S
MMW-P-05	Michigan Plaza	1857866	14445120	715.55	18	28	28	697.55	687.55	S
GP-05	Michigan Plaza	1857866	14445120	715.55	18	28	28	697.55	687.55	S
MMW-P-06	Michigan Plaza	1857815	14445112	716.14	18	28	28	698.14	688.14	S
MMW-P-07	Michigan Plaza	1857814	14445273	714.9	18	28	28	696.9	686.9	S
MMW-P-08	Michigan Plaza	1857854	14445274	714.53	18	28	28	696.53	686.53	S
MMW-P-09D	Michigan Plaza	1858104	14444478	714.82	35	45	45	679.82	669.82	D
MMW-P-09S	Michigan Plaza	1858104	14444478	714.8	18	28	28	696.8	686.8	S
MMW-P-10D	Michigan Plaza	1857869	14445246	714.42	28	38	38	686.42	676.42	I
MMW-P-10S	Michigan Plaza	1857869	14445246	714.35	18	28	28	696.35	686.35	S
MMW-P-11S	Michigan Plaza	1857792	14445468	716.42	16	26	26.65	700.42	690.42	S
MMW-P-11D	Michigan Plaza	1857792	14445468	716.42	16	26	26.65	700.42	690.42	S
MMW-P-12D	Michigan Plaza	1857720	14445251	715.33	31.5	36.5	36.5	683.83	678.83	I
MMW-P-12S	Michigan Plaza	1857720	14445251	715.83	16	26	26	699.83	689.83	S
MMW-P-13D	Michigan Plaza	1857543	14444969	713.57	28	33	33	685.57	680.57	I
MMW-P-13S	Michigan Plaza	18575	144449	713.83	16	26	26	697.83	687.83	S

		54	78							
MW-0102-S2	Allison Transmission	1855955	14446148	717.22						S
MW-0104-S2	Allison Transmission	1855497	14446188	719.28						S
MW-0105-S2	Allison Transmission	1855013	14445739	721.03						S
MW-0106-S2A	Allison Transmission	1854810	14445813	721.48						S
MW-0107-S2	Allison Transmission	1855511	14445734	719.64						S
MW-0116-S2	Allison Transmission	1854591	14445705	721.69						S
MW-0202-S2A	Allison Transmission	1855611	14446355	718.59						S
MW-0202-S2B	Allison Transmission	1855612	14446358	718.72						D
MW-0202-S3	Allison Transmission	1855612	14446363	718.48						D
MW-0210-S3	Allison Transmission	1855821	14446326	718.22						D
MW-0402-S3	Allison Transmission	1855869	14446498	719.61	45	52	52	674.61	667.61	D
MW-0406-S2B	Allison Transmission	1855841	14446248	717.25						D
MW-0409-S2B	Allison Transmission	1855757	14446328	718.29						D
MW-0410-S2	Allison Transmission	1855077	14446324	721.74						S
MW-0412-S2	Allison Transmission	1855219	14446316	721.98						S
MW-0414-S2A	Allison Transmission	1855940	14446472	719.67	30	40	40	689.67	679.67	D
MW-0414-S3	Allison Transmission	1855940	14446472	719.58	35	43	43	684.58	676.58	D
MW-0417-S3	Allison Transmission	1855763	14446410	719.47	45	54	54	674.47	665.47	D
MW-0418-S2A	Allison Transmission	1855867	14446426	718.66	19	29	29	699.66	689.66	D
MW-0418-S3	Allison Transmission	1855879	14446425	719.17	45	52	52	674.17	667.17	D
MW-0420-S3	Allison Transmission	1855745	14446143	718.9						D
MW-0421-S2A	Allison Transmission	1855839	14446146	717.72						S
MW-0421-S3	Allison Transmission	1855832	14446145	717.68						D
MW-0427-S2B	Allison Transmission	1855822	14446342	718.19	27	39	39	691.19	679.19	D
MW-0522-S2A	Allison Transmission	1856236	14445098	719.38			28			S
MW-0522-S2B	Allison Transmission	1856241	14445097	719.35			44			S
MW-0523-S2	Allison Transmission	1855594	14444867	721.7						S
MW-0524-S2A	Allison Transmission	1856334	14445318	719.78			26.25			S

MW-0524-S2B	Allison Transmission	1856337	14445315	719.71			42			D
MW-0525-S2	Allison Transmission	1855868	14445613	719.64						S
MW-0526-S2A	Allison Transmission	1855617	14445212	719.86						S
MW-0526-S2B	Allison Transmission	1855622	14445212	720.38						D
MW-0622-S2A	Allison Transmission	1855665	14445208	720						S
MW-0623-S2A	Allison Transmission	1855699	14445098	718.93						S
MW-0624-S2	Allison Transmission	1855496	14445438	721.38						S
MW-0625-S2A	Allison Transmission	1855601	14445091	720.43						S
MW-0629-S2	Allison Transmission	1855333	14446265	721.46						S
MW-0629-S3	Allison Transmission	1855325	14446265	721.45						D
MW-0632-S2	Allison Transmission	1854976	14446132	720.5						S
MW-0709-S2	Allison Transmission	1855295	14446142	719.68						S
MW-0803-S2	Allison Transmission	1855261	14446144	720.2						S
MW-0814-S2	Allison Transmission	1855325	14445187	722.13						S
MW-0815-S2	Allison Transmission	1855403	14445116	721.91						S
MW-0816-S2	Allison Transmission	1855475	14445042	721.8						S
MW-0817-S2B	Allison Transmission	1855975	14446259	717.08						D
MW-0817-S3	Allison Transmission	1855975	14446252	717						D
MW-0818-S3	Allison Transmission	1855960	14446152	717.82						D
MW-0904-S3	Allison Transmission	1855965	14446330	718.2						D
MW-1001-S2B	Allison Transmission	1856268	14446171	717.61						D
MW-1001-S3	Allison Transmission	1856254	14446171	717.4						D
MW-1002-S2B	Allison Transmission	1856452	14446174	717.05						D
MW-1002-S3	Allison Transmission	1856465	14446176	717.41						D
MW-1002-S3-4	Allison Transmission	1856459	14446185	716.05						D
MW-1003-S3	Allison Transmission	1856341	14445294				55			S
MW-16-S2	Allison Transmission	1855269	14446161	720.28						S
MW-28-S2	Allison Transmission	1855422	14445137	722.09						S
MW-30-S2	Allison	18555	144450	720.89						S

	Transmission	04	60							
MW-31-S2	Allison Transmission	1855132	14445405	720.77						S
MW-32-S2	Allison Transmission	1855344	14445212	722.15						S
MW-33-S2	Allison Transmission	1855325	14445356	720.48						S
MW-34-S2	Allison Transmission	1855462	14445291	720.5						S
MW-3-9-S2	Allison Transmission	1854106	14445973	723.42						S
MW-S2-0601	Allison Transmission	1855680	14446239	718.03						S
MW-S2A-0501	Allison Transmission	1855790	14446264	717.5						S
MW-S2B-0501	Allison Transmission	1855795	14446265	717.37						D
MW-S3-0501	Allison Transmission	1855827	14446282	717.84						D
MW-S3-0601	Allison Transmission	1855674	14446240	718						D
MW-10-1R	Genuine Parts	1858050	14446241	714.74						S
MW-10-1	Genuine Parts	1858050	14446241	714.74						S
MW-132	Genuine Parts	1857444	14446479	711.54						S
MW-132R	Genuine Parts	1857444	14446479	711.54						S
MW-133	Genuine Parts	1857650	14446290	708.93						S
MW-133R	Genuine Parts	1857650	14446290	708.93						S
MW-135	Genuine Parts	1858028	14446515	713.48						S
MW-145	Genuine Parts	1857575	14446209	707.77	17.5	27.5	28	690.27	680.27	I
MW-146	Genuine Parts	1857898	14446182	708.41	15	25	25.3	693.41	683.41	I
MW-147A	Genuine Parts	1857448	14446491	711.45	20	30	30.5	691.45	681.45	I
MW-147AR	Genuine Parts	1857448	14446491	711.45	20	30	30.5	691.45	681.45	I
MW-148R	Genuine Parts	1857432	14446409	711.21	10.5	25.5	25.5	700.71	685.71	S
MW-148	Genuine Parts	1857432	14446409	711.21	10.5	25.5	25.5	700.71	685.71	S
MW-150	Genuine Parts	1858093	14446374	712.57	4	19	20	708.57	693.57	S
MW-151	Genuine Parts	1858115	14446101	712.6	5	20	20	707.6	692.6	S
MW-152	Genuine Parts	1857911	14446298	712.76	4.8	19.8	19.8	707.96	692.96	S
MW-153	Genuine Parts	1857511	14446282	711.5	4.5	19	20	707	692.5	S
MW-154	Genuine Parts	1857439	14446543	714	5	20	20	709	694	S

MW-155	Genuine Parts	1857345	14446378	717.32	14	29	29	703.32	688.32	S
MW-156	Genuine Parts	1858122	14446218	711.65	5	20	20	706.65	691.65	S
MW-158	Genuine Parts	1857253	14446383	719.94						S
MW-159	Genuine Parts	1858240	14445835	709.84						S
MW-160	Genuine Parts	1857653	14446125	702.18	3.5	13.5	13.5	698.68	688.68	S
MW-161	Genuine Parts	1857511	14446164	703.94	3.5	14.5	14.5	700.44	689.44	S
MW-162	Genuine Parts	1858120	14446484	712.73	10.5	20	20	702.23	692.73	S
MW-163	Genuine Parts	1858122	14446396	712.09	6.5	16.5	16.5	705.59	695.59	S
MW-164	Genuine Parts	1858400	14446165	718.23	21.5	26.5	26.5	696.73	691.73	S
MW-165D	Genuine Parts	1857557	14446045	712.19	42.5	48	48	669.69	664.19	D
MW-165S	Genuine Parts	1857552	14446045	712.31	10.5	20.5	20.5	701.81	691.81	S
MW-166D	Genuine Parts	1857631	14445822	712.49	46	52	52	666.49	660.49	D
MW-166S	Genuine Parts	1857626	14445824	712.7	10.5	20.5	20.5	702.2	692.2	S
MW-167D	Genuine Parts	1857564	14445329	715.61	28	33	33	687.61	682.61	I
MW-167S	Genuine Parts	1857557	14445328	716.07	12.5	22.5	22.5	703.57	693.57	S
MW-168D	Genuine Parts	1858056	14445299	714.46	21	31	31	693.46	683.46	I
MW-168S	Genuine Parts	1858051	14445299	714.58	12.5	22.5	22.5	702.08	692.08	S
MW-169D	Genuine Parts	1857775	14444586	715.69	32	37	37	683.69	678.69	I
MW-169S	Genuine Parts	1857779	14444585	715.92	15.5	26	26	700.42	689.92	S
MW-170D	Genuine Parts	1857344	14445034	717.07	34	39	39	683.07	678.07	I
MW-170S	Genuine Parts	1857343	14445038	717.14	17	27	27	700.14	690.14	S
MW-171D	Genuine Parts	1858137	14444972	711.62	44	49	49	667.62	662.62	D
MW-171S	Genuine Parts	1858137	14444976	711.58	12	22	22	699.58	689.58	S
MW-174S	Genuine Parts	1857337	14445526	717.78	14	24	24	703.78	693.78	S
MW-174D	Genuine Parts	1857337	14445526	717.72	43	48	48	674.72	669.72	D
MW-175S	Genuine Parts	1857336	14445761	718.66	15	25	25	703.66	693.66	S
MW-175D	Genuine Parts	1857336	14445761	718.75	37	42	42	681.75	676.75	I
MW-200	Genuine Parts	1858059	14446335	712.72	45	50	50	667.72	662.72	D
MW-201	Genuine Parts	18581	144460	712.01	36	38	50	676.01	674.01	I

MMW-15S	Apartments	1857444	14445767	713.36	22	32	32	691.36	681.36	I
MMW-15D	Apartments	1857451	14445767	713.08	34	39	39	679.08	674.08	I
MMW-C-02S	Cemetery	1857970	14444756	715.21	18	28	28	697.21	687.21	S
MMW-C-16S	Cemetery	1857755	14444816	717.32	15.9	25.9	25.9	701.42	691.42	S
MMW-P-14S	cemetery	1857365	14444812	714.5	18	28	28	696.5	686.5	S
GP-C-09	cemetery	1857977	14444772	713.9	31	36	36	682.9	677.9	I
MMW-C-02D	cemetery	1857977	14444772	713.9	31	36	36	682.9	677.9	I
MMW-C-16D	cemetery	1857757	14444799	717.27	35	40	40	682.27	677.27	I
MMW-C-17D	Cemetery	1858291	14444173	714.57	33.7	38.7	38.7	680.87	675.87	I
MMW-P-11DR	Cemetery	1857665	14444976	715.63	28	33	33	687.63	682.63	I
MMW-P-14D	Cemetery	1857365	14444790	714.76	29	34	34	685.76	680.76	I
SG-1	SG	1857424	14446140	701.78	0	0	0	685.76	680.76	S
SG-2	SG	1858206	14445154	698.85	0	0	0	685.76	680.76	S
Residential Well										
RES4012COS		1857152	14444226	714.3936		59	62	62	655.39	D
RES4018WVS		1856971	14444698	717.0758		75	80	80	642.08	D
RES4239WCOS		1857486	14445557	717		50	55	55	667	D
RES4020COS		1858128	14444848	717		51	54	54	666	D
RES3908WCOS		1857661	14444094	717		47	50	50	670	D
RES3659WCOS		1858973	14443520	717		41	46	46	676	D
RES3940WCOS		1857894	14443930	717		31	33	33	686	I
RES4042WVS		1856530	14445175	717		34.5	35	35	682.5	D
RES4044WVS		1856988	14443980	717		72	75	75	645	D
RES4017COS		1857152	14444062	717		51	54	54	666	D
RES4140WVS		1856205	14445533	717		32	36	36	685	D

Table 1-2. Groundwater Elevation Data

Monitoring Well	GWE 12-1-11	GWE 7-30-12	GWE 3-1-13	GWE 10-1-10 DRY	GWE 4-28-11 WET
MW-WES-02a	696.01	695.62	697.49		
MW-WES-03a	694.72	694.19	696.3		
MW-WES-04a	697.11	695.9	697.78		
MW-WES-05a	697.52	697.37	699.06		
MMW-10S	697.07	695.64	697.18	695.48	
MMW-11S	697.66	696.19	697.73	696.09	
MMW-12S	697.65	696.05	697.55	696.74	
MMW-1S	697.53	696.12	697.66	695.99	
MMW-2S	697.83		698.02		
MMW-7S	698.52	697.21	698.41	696.98	
MMW-8S	697.68	696.99	697.95	696.21	
MMW-9S	697.1	695.69	697.21	695.46	
MMW-C-01	696.1	694.97	696.87	694.74	
MMW-C-02s	695.48	694.54	696.25	694.36	
MMW-P-01	696.38	695.2	697	695.08	698.35
MMW-P-02	696.03	694.98	696.88	694.81	698.3
GP-02					
MMW-P-03S	696.08	694.96	696.85	694.85	698.27
MMW-P-04	696.31	695.16	697.01	694.84	698.5
MMW-P-05	696.29	695.13	696.96	694.98	698.35
GP-05					
MMW-P-06	696.24	695.13	696.99	695.37	698.38
MMW-P-07	696.91	695.49	697.42	695.31	698.57
MMW-P-08	697.02	695.67	697.39	695.54	698.63
MMW-P-09S	695.02	694.13	695.76	694.01	697.13
MMW-P-10S	697.35	695.54	697.32	695.36	698.79
MMW-P-11S	695.89	694.91	696.85		
MMW-P-12S	697.36	696.29	697.88		
MMW-P-13S	695.77	694.91	696.92		
MW-167S	697.7	696.52	698.15	696.09	699.77
MW-168S	697.29	695.82	697.34	695.37	698.58
MW-169S	695.38	694.5	696.42		697.83
MW-170S	695.86	695.07	697.13	694.7	698.43
MW-171S	696.23	695.99	696.38		697.66
MW-174S	697.31	695.38	697.81		
MW-175S	697.55	696.98	697.85		
MMW-C-02S		694.54	696.25	694.36	697.29
MMW-C-16S		694.62	696.51		
MMW-P-14S		694.54	697.25		
SG-1		701.52	701.02		

SG-2					
MW-WES-01a	695.71	695.1	697.62		
MW-WES-03b	694.73	694.13	696.23		
MW-WES-04b	696.89	695.87	697.94		
MW-WES-05b	697.49	696.35	698.1		
MMW-11D	697.66	696.52	698.05	697.03	
MMW-3S	698.44	696.96	698.11	696.67	
MMW-P-03D	696.13	695.01	696.91	694.83	698.32
MMW-P-10D	696.78	695.42	697.11	695.31	698.42
MMW-P-12D	697.49	696.31	697.95		
MMW-P-13D	695.76	696.46	696.91		
MW-145	699.33				
MW-146	699.21				
MW-147A					
MW-147AR	700.61				
MW-167D	697.66	696.49	698.1		699.38
MW-168D	697.22	695.78	697.26	695.23	698.56
MW-169D	695.34	694.48	696.4		697.86
MW-170D	695.87	695.07	697.13	694.64	698.42
MW-175D	697.75	697.12	698.04		
MW-201	700.39				
MMW-15S		696.47	697.97		
MMW-15D		696.48	698.07		
GP-C-09					
MMW-C-02D		694.56	696.27		
MMW-C-16D		694.6	696.52		
MMW-C-17D		693.42	695.02		
MMW-P-11DR		694.9	696.86		
MMW-P-14D		694.52	696.63		
MMW-P-11D					
MW-WES-01c	695.85	694.79	696.86		
MW-WES-01b	695.61	694.84	696.89		
MW-WES-02b	695.97	695.12	697.16		
MW-WES-02c	696.63	695.16	697.2		
MW-WES-05c	697.45	695.3	697.05		
MMW-13D	697.77	696.46	698.02	696.34	699.33
MMW-14D	697.69	696.54	697.98	696.15	699.25
MMW-4D	698.24	696.82	698.18	696.63	699.55
MMW-5D	698.43	697.07	698.29	696.87	699.65
MMW-6D	698.43	697.11	698.24	696.92	699.74
MMW-P-09D	695.11	694.15	695.81	693.97	697.18
MW-165D	698.64				
MW-166D	698.16	696.78	698.24		

MW-171D	695.71	694.62	696.15	694.23	697.52
MW-174D	696.95	695.45	697.8		
MW-200	699.72				
RES-4012 COS					
RES-4018 WVS					
RES-4042 WVS					
RES-4044WVS					
MW-132R	700.64				
MW-147AR	700.61				
MW-154	700.68				
MW-160	698.88				
MW-161	699.05				
MW-165D	698.64				
MW-165S	698.58				
MW-166D	698.16	696.78	698.24		
MW-166S	698.12	696.75	698.23		
	697.66	696.49	698.1		
	697.7	696.52	698.15		
MW-169D	695.34	694.48	696.4		
MW-169S	695.38	694.5	696.42		
MW-10-1R	699.51				
MW-133R	699.85				
MW-135	700.14				
MW-145	699.33				
MW-146	699.21				
MW-148R	700.49				
MW-150	699.23				
MW-152	699.54				
MW-153	700.04				
MW-302					
IW-1					
IW-2					
MW-151	698.82				
MW-156	699.67				
MW-157					
MW-163	701.34				
MW-164	698.83				
MW-173					
MW-305					
MW-0102-S2	697.05				
MW-0104-S2	702.1				
MW-0105-S2	695.25				
MW-0106-S2A	697.7				

MW-0107-S2	697.09
MW-0116-S2	696.47
MW-0202-S2A	694.91
MW-0202-S2B	697.03
MW-0202-S3	694.8
MW-0210-S3	694.57
MW-0406-S2B	696.98
MW-0409-S2B	695.01
MW-0410-S2	700.29
MW-0412-S2	699.31
MW-0420-S3	694.87
MW-0421-S2A	697.18
MW-0421-S3	694.96
MW-0427-S2B	696.95
MW-0522-S2A	695.71
MW-0522-S2B	695.64
MW-0523-S2	694.65
MW-0524-S2A	696.3
MW-0524-S2B	696.22
MW-0525-S2	697
MW-0526-S2A	696.97
MW-0526-S2B	695.94
MW-0622-S2A	696.49
MW-0623-S2A	695.77
MW-0624-S2	696.56
MW-0625-S2A	695.5
MW-0629-S2	702.28
MW-0629-S3	695.11
MW-0632-S2	697.95
MW-0709-S2	701.51
MW-0803-S2	695.08
MW-0814-S2	694.82
MW-0815-S2	694.74
MW-0816-S2	694.99
MW-0817-S2B	696.71
MW-0817-S3	695.06
MW-0818-S3	695.16
MW-0904-S3	694.99
MW-1001-S2B	697.51
MW-1001-S3	696.45
MW-1002-S2B	697.74
MW-1002-S3	696.97
MW-1002-S3-4	697.13

MW-1003-S3	
MW-16-S2	701.04
MW-28-S2	694.89
MW-30-S2	694.07
MW-31-S2	695.37
MW-32-S2	694.71
MW-33-S2	695.35
MW-34-S2	697.11
MW-3-9-S2	698.26
MW-S2-0601	697.2
MW-S2A-0501	698.82
MW-S2B-0501	697.04
MW-S3-0501	695.07
MW-S3-0601	694.68

Table 1-3 Monitoring Well Water Quality data: Specific conductance

MW	SpC2007	SpC highest 2008 value	SpC2009 (3/2009)	SpC2010 (4/2010)	SpC 2011 Weston data or 5/2011	SpC2012	SpC 2013 (May)	SpC 2013 (9/2013) post injections
MW-WES-02a					1787		1062	1062
MW-WES-03a					1671		1242	1242
MW-WES-04a					887		717	647
MW-WES-05a					1978		778	1105
MMW-10S	1400	5514	3510	1835	1630	1884	2140	1638
MMW-11S	880	3618	2887	960	1108	858	1346	972
MMW-12S			2818	1046	1075	1105	1475	1050
MMW-1S	920	3753	2794	1309	1258	1198	1618	1223
MMW-2S		868		786	619	694	1133	
MMW-7S		3119		1013	1080	632	1273	
MMW-8S	780	3385	2647	891	2259	986	1848	1301
MMW-9S	1500	5173	3678	2012	1878	1864	1978	1340
MMW-C-01		2908	2702	723	463	791	1532	1098
MMW-C-02s		2807	2507	787	689	738	1232	810
MMW-P-01		5619	3419	1493	1978	1698	3293	1877
MMW-P-02		4637	3641	1346	1264	1437	1502	1006
GP-02								
MMW-P-03S		5093	3372	970	1227	971	1109	1315
MMW-P-04		1417		808	1040	769		877
MMW-P-05		6086	2670	1003	1036	734	1819	1177
GP-05								
MMW-P-06		4294	3884	1129	1338	1283	2919	1483
MMW-P-07		6056	4022	1924	1632	1841	2741	1879
MMW-P-08		3646	4083	1804	2362	1709	2765	1092
MMW-P-09S		3920	2249	640	587	709	1155	790
MMW-P-10S		4590	3958	971	1583	673	1989	1200
MMW-P-11S					802	861	1697	968
MMW-P-12S					1106	1173	1990	1469
MMW-P-13S					925	566	583	849
MW-167S				1212	916	1626	3580	
MW-168S		1395						
MW-169S	1045			848	975		1891	
MW-170S		1438		1489	1241	1488	2783	1506
MW-171S		2715			799	792		
MW-174S								
MW-175S					530			

MMW-C-02S		2807	2507	787	812	748	1232	
MMW-C-16S						1141	2374	1020
MMW-P-14S						1242	1886	1102
SG-1								
SG-2								
MW-WES-01a					2195		1058	679
MW-WES-03b					1062		1408	1282
MW-WES-04b					920		867	698
MW-WES-05b					1857		958	859
MMW-11D			2745	946	906	960	1313	974
MMW-3S		2673		933	892	893	1453	
MMW-P-03D		1719	3253	1143	1195	1374	1975	1366
MMW-P-10D		4184	2734	857	598	1225	2242	1560
MMW-P-12D					1070	1323	1882	1489
MMW-P-13D					909	871	989	1003
MW-145	1356	2480	1870					
MW-146	908	1186	1135	1025	1150	1040	929	
MW-147A	1417	3274	2970	1370	2000			
MW-147AR								
MW-167D	791	2800		803	910	855	2013	811
MW-168D		1283	2948	1128	1056	1383	1018	1394
MW-169D	1080	3355		783	880	1062	2524	
MW-170D		970		1149	1040	1587	2191	1350
MW-175D					1306			
MW-201								
MMW-15S						804	1799	1039
MMW-15D						921	1237	604
GP-C-09								
MMW-C-02D						810	686	794
MMW-C-16D						1241	2600	1283
MMW-C-17D						910	2089	883
MMW-P-11DR					802	861	1697	969
MMW-P-14D						1114	2003	1377
MMW-P-11D								
MW-WES-01c					1024		566	604
MW-WES-01b					2787		1139	799
MW-WES-02b					1774		1095	865
MW-WES-02c					1077		1009	752
MW-WES-05c					1996		834	612
MMW-13D			2421	828	878	904	776	883
MMW-14D		5198	2191	751	738	852	1405	873
MMW-4D		1541		1210	1228	1290	1835	1452
MMW-5D		1090		1064	1472	668	1371	

MMW-6D			2907		1061	1239	733	1194	771
MMW-P-09D			8894	2616	885	852	880	1372	879
MW-165D	847		971	959	1307	1600	849	1210	
MW-166D	756		1028	980	980	1210	1370	817	
MW-171D			3179		846	888	891	962	
MW-174D									
MW-200									
RES-4012 COS									
RES-4018 WVS									
RES-4042 WVS									
RES-4044WVS									
MW-132R	892		2550	2750	1074.00	1090			
MW-147AR	1417		2870	2970	1370.00	2000			
MW-154	1890		2350	2470		2890	1260	1390	
MW-160	1436		1321	1043	1747.00	2210			
MW-161	869		1700	958	986	1730	865		
MW-165D	847		971	945	1307	1600	849	1210	
MW-165S	592		988	881	1252	3360	1110	1380	
MW-166D	756		1028	980	980	1210	1370	817	
MW-166S	725		1093	1049	941	1210	1230	1030	
MW-169D	1080		1040	1112	1091	1030			
MW-169S	1045		988	1100	1055	1100			
MW-10-1R	800		849	812	886	910	778	861	
MW-133R	1090		1283	1425	1146	1550			
MW-135	744		744	594					
MW-145	1356			1870					
MW-146	908		1186	1135	1025	1150	1040	929	
MW-148R	1357		1741	1530	1260	1890	1260	1690	
MW-150	904		920	942	921	977	926	931	
MW-152	502		792	795	551	872	591	601	
MW-153	1310		1455	1840	1717	2840	1740	1380	
MW-302	564		697	695	649	688			
IW-1	1139		2630	943	1044	1430			
IW-2	774		855	741	718	805	901		
MW-151	916		959	848	614	982	874	924	
MW-156	818		936	934	716	761	762	852	
MW-157	717		743	776	849				
MW-163	847		920	815	962	905	832	1000	
MW-164	966		925	959	948	1100	1000	992	
MW-173	693		785	698	692	799	773	781	
MW-305			396						

Table 1-4. PCE, VC, and Methane Data

MW	PCE 2013	PCE All	VC 2013	VC All	Methane (oldest available)	Methane (5/2011)	Methane (8/2012)	Methane (9/2013)	Methane (11/2013)
MW-WES-02a	0	0	0	0				0	0
MW-WES-03a	0	0	0	0				0	0
MW-WES-04a	0	0	0	0				0	0
MW-WES-05a	0	0	0	0				0	0
MMW-10S	6.6	37.8	463	278		9700	9800	9890	11000
MMW-11S	0	7.2	0	10.8	18				
MMW-12S	0	0	9.2	114					
MMW-1S	219	400	45.1	39	270	12	15,000	24700	427
MMW-2S	0	0	0	5.2					
MMW-7S	0	0	0	4.5					
MMW-8S	22.5	7.8	163	206		7600	14000	25000	27400
MMW-9S	21.5	5.7	1370	784	4400	12000	17000	7590	7310
MMW-C-01	12.2	15.6	19.6	119		14	14000	16300	16200
MMW-C-02s	0	0	0	0					
MMW-P-01	28.1	18.1	1070	2120		3000	15000	12700	13200
MMW-P-02	11.2	35.6	165	724		17000	15000	4370	11800
GP-02									
MMW-P-03S	0	0	2500	347	59	21000	17000	14200	22700
MMW-P-04	0	0	10.3	68.7		10000	19000	22900	23200
MMW-P-05	0	0	248	53.9	9900	15000	1800	8600	4980
GP-05									
MMW-P-06	0	0	2590	10500	290	17000	15000	18800	25300
MMW-P-07	0	0	239	871		6000	16000	16500	11200
MMW-P-08	0	0	197	245	2800	6800	9200	7340	14300
MMW-P-09S	0	0	0	0	8				
MMW-P-10S	0	192	2.3	419	50	5800	12000	11800	8790
MMW-P-11S	215	471	8.7	12.7		690	5200	297	2100
MMW-P-12S		0	19.4	66.7	24	24	17	73	1180
MMW-P-13S	0	0	0	32.4		4			
MW-167S									
MW-168S	76	0	57.1	34	17				
MW-169S	0	0	0	0					
MW-170S	0	0	0	0					
MW-171S	0	0	0	0					

MW-174S	0	0	0	0					
MW-175S	0	0	0	0					
MMW-C-02S	0	0	0	0					
MMW-C-16S	0	0	0	0					
MMW-P-14S	0	0	0	0					
SG-1	0								
SG-2	0								
MW-WES-01a	0	0	0	0				0	0
MW-WES-03b	0	0	10.7	10.7				29	64
MW-WES-04b	0	0	0	0				0	0
MW-WES-05b	0	0	0	0				5.5	14.6
MMW-11D	0	0	7.7	7.8					
MMW-3S	0	0	0	4.4					
MMW-P-03D	0	0	664	179	1200	14000	21000	1130	28800
MMW-P-10D	0	0	2020	1780		18000	20000	29800	26700
MMW-P-12D	0	0	37.8	96.1		26	20	15	117
MMW-P-13D	0	0	120	170		20			
MW-145		0		6.1					
MW-146		0		0					
MW-147A		0		0					
MW-147AR		0		0					
MW-167D			9.6	19.6					
MW-168D	0	0	100	122	16000				
MW-169D	0	0	27.2	22.6					
MW-170D	0	0	48	63.6					
MW-175D	0	0	0	0					
MW-201	0								
MMW-15S	0	0	0	0					
MMW-15D	0	0	2.7	2.7					
GP-C-09	0								
MMW-C-02D	0	0	275	162					
MMW-C-16D	0	0	165	349					
MMW-C-17D	0	0	5.6	2.1					
MMW-P-11DR	0	0	101	102			590	290	1020
MMW-P-14D	0	0	94.4	58.3					
MMW-P-11D									
MW-WES-01c	6	7.4	18.1	18.1				20	551

MW-WES-01b	0	0	20.2	65.2				0	31.2
MW-WES-02b	0	0	6.7	17.9				0	0
MW-WES-02c	0	0	3.3	2.1				310	409
MW-WES-05c	0	0	0	0				0	0
MMW-13D	0	0	139	182					
MMW-14D	0	0	150	140					
MMW-4D	0	0	124	206					
MMW-5D	0	0	168	94.1					
MMW-6D	0	0	49.4	75.2					
MMW-P-09D	0	0	67.5	85.7					
MW-165D			166	167					
MW-166D			250	469					
MW-171D	0		4.7	9.5					
MW-174D	0	0	0	0					
MW-200									
RES-4012 COS	0	0	26.1	26.1					
RES-4018 WVS	0	0	4.8	4.8					
RES-4042 WVS	0	0	0	0					
RES-4044WVS	0	3	4.7	4.7					
MW-132R		0	0	0					
MW-147AR		0		0					
MW-154				0					
MW-160		0		17					
MW-161		0		0					
MW-165D				167					
MW-165S									
MW-166D				469					
MW-166S									
MW-169D		0		27.1					
MW-169S									
MW-10-1R				4.2					
MW-133R				0					
MW-135		0		0					
MW-145		0		6.1					
MW-146		0		0					

MW-148R		0		120					
MW-150		0		0					
MW-152		0		0					
MW-153		0		0					
MW-302									
IW-1									
IW-2									
MW-151		0		0					
MW-156		0		0					
MW-157		0		0					
MW-163		0		52					
MW-164		0		0					
MW-173		0		0					
MW-169D		0		0					